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ND GENERATION CONTROL FORTRAN SOFTWARE

Urban Traffic Control System (UTCS) Software Support Project

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Vol. I 2GCF Routines - Program Descriptions

June 1976
Final Report

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FOREWORD

This report documents the results of the research performed to date on the Second Generation UTCS Software System. This system provides for on-line traffic signal optimization. The documentation will be of interest to urban traffic engineers of cities who desire to undertake experiments to determine the effectiveness of applying second generation control software (in comparison with first generation type software) for various types of networks or portions of networks.

This report is comprised of three volumes which detail the second generation software which was converted from machine dependent language to FORTRAN and those enhancements to the original software made during the conversion effort. This project was conducted for the Federal Highway Administration, Office of Research, Washington, D. C., under Contract DOT-FH-11-8317 "UTCS Software Support."

While the software system described in this report was operational in the Washington, D. C., test facility, it will require additional programing effort to render it operational in other cities. It is this same software system that will receive further investigation and become the subject of future research by the Federal Highway Administration.

Sufficient copies of this report are being distributed in sets of three volumes by FHWA bulletin to provide a minimum of one set to each FHWA regional office, one set to each FHWA division office, and one set to each State highway agency. Direct distribution is being made so that the State and division office copies are sent to the division offices.

Charles F. Scheffey
Director, Office of Research

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15. Supplementary Notes

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16. Abstract

The Second Generation UTCS developed by TRW was converted from its machine dependent language to FORTRAN. Enhancements to the system included an improved technique for determining when traffic signal timing pattern recomputation should occur; a change to provide for maintenance of user defined signal phase splits or offsets; a recoding of the link/phase correlation; a modification in the offset optimization algorithm to properly compare optimum solutions for alternate cycle lengths; and numerous corrections to the UTCS data base. File maintenance for the source programs was developed, and all source images are in easily-modified magnetic tape formats. A source language editing program was added to the system library for the 2GC FORTRAN system. Documentation for routines which remain unchanged from the original 2GC was updated to reflect new documentation standards.

Volume I - 2GCF Routine Program Descriptions

Volume II - 2GCF Routine Program Descriptions (Concluded)

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TABLE OF CONTENTS

Section			Page
1	INTRODUCTION		1
2	THE UTCS/2GCF SOFTWARE SYSTEM		3
	2.1 Organization of UTCS CPU Functions		3
	2.2 Priority Interrupt System		4
	2.3 UTCS/2GCF Routines and Functions		6
	2.4 Philosophy of the Second Generation Software		8
	2.5 Overview of the First and Second Generation Software Interface		10
	2.6 Second Generation (FORTRAN) - 2GCF - Routines		14
	2.6.1	Routine A	15
	2.6.2	Subroutine A5	28
	2.6.3	Subroutine CHECK (A, B)	31
	2.6.4	Subroutine CRTOUT	33
	2.6.5	Routine A1	35
	2.6.6	Subroutine BUFFERIN/OUT	40
	2.6.7	Subroutine PKBL2	42
	2.6.8	Subroutine UPBL2	45
	2.6.9	Subroutine UPKMC	48
	2.6.10	Routine B	50
	2.6.11	Routine C	56
	2.6.12	Routine E	59
	2.6.13	Routine F	66

TABLE OF CONTENTS (Continued)

Section		Page
2.6.14	Routine H	69
2.6.15	Subroutine CAL15	83
2.6.16	Subroutine CALRL	85
2.6.17	Subroutine DECON	87
2.6.18	Subroutine E1SRT	90
2.6.19	Subroutine LKDAT	93
2.6.20	Subroutine MHEAD	97
2.6.21	Subroutine OUTAP	100
2.6.22	Subroutine OUT2G	104
2.6.23	Subroutine PRNTF	109
2.6.24	Subroutine SBYTC	112
2.6.25	Subroutine STAT	114
2.6.26	Subroutine STMSG	120
2.6.27	Subroutine TIMEH	123
2.6.28	Subroutine TSTAP	126
2.6.29	Subroutine TSTLP	130
2.6.30	Routine I	134
2.6.31	Subroutine PRPRED	145
2.6.32	Routine J	155
2.6.33	Subroutine BCDTH	172
2.6.34	Subroutine CDL	174
2.6.35	Subroutine CLS	178

TABLE OF CONTENTS (Continued)

Section		Page
2.6.36	Subrouting SDL	180
2.6.37	Subroutine TCSLP	183
2.6.38	Routine K	186
2.6.39	Subroutine CIC	202
2.6.40	Subroutine CNVT	204
2.6.41	Subroutine CRLF	208
2.6.42	Subroutine DCMAL	210
2.6.43	Subroutine DISIN	212
2.6.44	Subroutine DISNM	215
2.6.45	Subroutine GREEN	217
2.6.46	Subroutine KFTU	221
2.6.47	Subroutine TODAY	224
2.6.48	Subroutine TRIG	227
2.6.49	Subroutine SCODE	229
2.6.50	Subroutine SETCR	232
2.6.51	Routine M	234
2.6.52	Subroutine HFMT	287
2.6.53	Subroutine KFMT	289
2.6.54	Subroutine MSUB	293
2.6.55	Subroutine MSUB2	297
2.6.56	Subroutine SRCFT	298
2.6.57	Routine O	300

TABLE OF CONTENTS (Concluded)

Section		Page
2.6.58	Subroutine PCKO	303
2.6.59	Subroutine UNPO	305
2.6.60	Routine P	307
2.6.61	Subroutine PCKP1	311
2.6.62	Subroutine UNPP1	313
2.6.63	Subroutine UNPP2	315
2.6.64	Routine Q	317
2.6.65	Subroutine Q1	320
2.6.66	Subroutine CALOP	322
2.6.67	Subroutine MOVER	326
2.6.68	Routine R	329
2.6.69	Routine S	332
2.6.70	Subroutine MBYTS	339
2.6.71	Subroutine UNPS	342
2.6.72	Routine T	346
2.6.73	Subroutine PCKT	355
2.6.74	Subroutine UNPT	357

LIST OF ILLUSTRATIONS

Figure		Page
1	UTCS/2GCF Priority Level Two Routines	11
2	UTCS/2GCF Priority Level Five Routines	13
3	Intersection Status Report	70
4	Log of Control Panel System Requests Made during Last 15 minutes	72
5	Controller Status Report	72
6	System Status Report by Section	72
7	UTCS System Performance Report by Link	73
8	15-Minute Measure of Effectiveness (MOE) Tape Format	101
9	UTCS System Summary, End-of-Day Report	135
10	Map Signal Output Array	162
11	Failure Status Format	188
12	System Status Format	189
13	Controller Status Report	190
14	Detector Status Report	191
15	Intersection Status Format	193
16	Control Panel Output Bit Assignments	235
17	Control Panel Input Bit Assignments	236

SECTION 1
INTRODUCTION

A second generation Urban Traffic Control System (UTCS-2GC) has been implemented by the Federal Highway Administration in the District of Columbia. This document presents the FORTRAN version (UTCS/2GCF) of this software. [1]

Developed by Sperry Systems[2], the first generation UTCS demonstrated that computer technology could deal with the complex problems of traffic control. This first generation UTCS was capable of choosing a fixed timing plan that best fit the actual traffic situation from a large selection of timing plans. UTCS/2GC, developed by TRW, utilizes software that computes intersection timing plans and offers the greatest potential for coping with the current and predicted traffic environment. This second generation software package uses the executive structure, the surveillance computations, and the command software of the first generation UTCS.

Both UTCS and UTCS/2GC were implemented on a Xerox Data System (XDS) Sigma-5 computer in the District of Columbia. The Honeywell developed UTCS/2GCF software is constructed using the XDS Real Time Batch Monitor (RBM-CO4) operating system and requires 60491 words of core memory. The Level 5 routines are overlayed and do not occupy core memory simultaneously.

The UTCS/2GC software, with the exception of the Level 5 routines, was originally coded in MACRO-SYMBOL assembly language. Except for routines dealing with executive operations, input/output, and data packing and unpacking, this software has been translated to FORTRAN IV. This translation maintains the original logic structure of the package. FORTRAN IV, a machine independent language, requires a minimum amount of recoding

if the software is adapted to another hardware configuration. The MACRO SYMBOL routines are machine dependent and must be rewritten for other hardware configurations. The entire software system is described in this document with the intent that the FORTRAN software may be readily adaptable to other computers and traffic control systems.

SECTION 2
THE UTCS/2GCF SOFTWARE SYSTEM

This section includes a description of the organization of the UTCS CPU functions and a description of the priority interrupt system. Also included is a list of all routines in the UTCS/2GCF system and the functions of each are stated. Finally, the requirements and philosophy of the second generation control software are discussed, and an overview of the interface between the second generation control outputs and the first generation signal timekeeping routines is given.

2.1 ORGANIZATION OF UTCS CPU FUNCTIONS

The UTCS/2GCF computer routines are organized in accordance with the frequency with which the various functions are required to be performed. The UTCS Executive Routine controls the sequence by which other UTCS cyclical routines are performed in accordance with pre-defined assignments of priority and elapsed time. Functions that are performed 32 times per second are specified in routines that are assigned to Priority Level 1. Priority Level 2 routines are those that are entered twice per second. All the remaining first generation routines except the start-up routines are assigned to Priority Level 3. The start-up routine is not assigned to a priority level. The CRT output routine is assigned to Priority Level 4 and the 2GCF on-line network optimization package is assigned to Priority Level 5.

The timing for the UTCS Executive Routine is controlled by an internal clock which causes a program interrupt 32 times per second. When the interrupt occurs, any routine in progress is suspended and control is given to the UTCS Executive Routine which performs all multiplexer (MUX) input/output

(I/O), and executes the UTCS Level 1 routines. When a half-second mark is encountered, the UTCS Executive Routine causes the Priority Level 2 routines to be performed. At the completion of Priority Level 1 and (if on the half-second) Priority Level 2, the UTCS Executive Routine allows the Priority Level 3 routines to be resumed from the point at which they had been interrupted. The Priority Level 4 interrupt is triggered every 25 seconds to update the CRT status pages. The Priority Level 5 interrupt is triggered every 5 MINCT seconds (currently 5 minutes). The Priority Level 5 Executive is entered upon triggering this interrupt. This executive determines if Priority Level 5 processing is required. The Monitor allows the lower level priority routines to be resumed from the point at which they were interrupted by the Priority Level 1 and 2 routines.

2.2 PRIORITY INTERRUPT SYSTEM

Twelve external interrupts are installed on the UTCS Sigma 5 CPU. A listing of the present external interrupts' tasks is contained in Table 1. In addition to the external interrupts, an internal clock pulse decrements a counter 8000 times per second. When the counter is decremented every 1/32 of a second to zero, the Counter Equals Zero interrupt in location X'5A' (where X signifies hexadecimal) is triggered, causing a portion of the UTCS executive routine to set the counter to its initial value of 250 and trigger the UTCS Level 1 interrupt. Note that the internal clock interrupt in location X'5A' has a higher priority than the external interrupts listed in Table 1.

The priority triggering structure of the UTCS CPU is shown in Table 2. Every 1/32 of a second, the Counter Equals Zero internal clock interrupt triggers the UTCS Level 1 external interrupt. The UTCS Level 1 interrupt causes the UTCS Executive Routine to transfer the required data to and from the I/O Multiplexer and to initiate the processing of the detector inputs. When 1/2 second has elapsed, the UTCS Level 2 and Level 3

external interrupts are triggered by the UTCS Executive Routine. The Level 2 routines are primarily controller oriented. At the completion of Level 2, the 15-minute report routine is performed at Level 3 if the 15-minute flag is set. At Level 3 the end-of-day report routine is also performed if the end-of-day flag is set. After completion of Level 3, the Level 4 external interrupt is triggered if there is a CRT request. The Priority Level 5 external interrupt is triggered every 5MINCT seconds by the Monitor (currently 5 minutes). The Priority Level 5 executive is then entered to determine if the Level 5 routines should be executed. When the Priority Level 5 routines have completed execution, the Monitor allows the system to perform batch processing or idle until the next 1/32 second clock interrupt.

Table 1. Sigma 5 Interrupt Structure (External Group 2)

- UTCS CPU

Location	Function	
X '60	Not used	
'61	Not used	
62	Level 1 (1/32 second timing)	
63	Level 2 (1/2 second timing)	
64	Level 3 (other cyclical routines)	
65	Not used	
66	CRT Input (not used)	Used by Monitor
67	Output to CRT	
68	Level 4 (CRT Output Routine)	
69	Level 5 (2GCF MACRO Loop)	
6A	Not used	
6B	Monitor Control Task	

Table 2. Priority Triggering Structure

Interrupt	Triggered By
UTCS Level 1	Counter Equals Zero (1/32 second)
UTCS Level 2	UTCS Executive Routine
UTCS Level 3	UTCS Executive Routine
UTCS Level 4	Routine K
UTCS Level 5	UTCS Executive Routine
Monitor Batch Mode	RBM

2.3 UTCS/2GCF ROUTINES AND FUNCTIONS

The entire UTCS/2GCF system is comprised of routines that are assigned to one of the five priority levels discussed in the previous subsection. Priority Level 1 routines embody these functions which are directly associated with the measurement of vehicular traffic and executive control.

The Priority Level 2 routines are primarily those associated with controller commands, error checking, and data evaluation. Central to the Priority Level 2 functions are a sequence of routines performed for each controller. These routines provide the required functions for sequencing the controller through its cycle, placing it on or off-line as desired, and adjusting split and offset in accordance with traffic volumes or operator commands. Other Level 2 routines provide error checking for each controller, controller cycle timekeeping, data computation, and the operation of semi-actuated controllers.

The Priority Level 3 routines provide the display and operator interface functions. Those data evaluation functions for which time is not critical are also performed by Priority Level 3 routines. Each routine is called

by the Level 3 portion of the Executive Routine and returns to the Level 3 portion of the Executive Routine when it is completed.

The Priority Level 4 routine updates the CRT status pages.

The Priority Level 5 routines embody the major functions of the Traffic Adaptive Network Signal Timing Program. These routines provide for traffic prediction, subnetwork determination, signal timing computation to optimize network flow, subnetwork interfacing, and transition optimization.

The major routines, their functions and priority level are listed in Table 3.

Table 3. UTCS/2GCF Routines and Functions

Routine	Function	Priority Level	Size
A	Executive	1	630
A1	Priority Level 2 Executive	2	202
B	Detector input data interpretation	1	116
C	Raw measure of effectiveness data processing	1	128
E	Detector and communication malfunction detection	3	410
F	Measure of effectiveness data computations and smoothing	3	244
H	System status report generation	3	332
I	End-of-day system status report generation	3	998
J	Map display driver	3	456
K	CRT display	3	1786
M	Manual control panel processing	3	694
O	A-Phase Green return processing	2	106

Table 3. UTCS/2GCF Routines and Functions (Concluded)

Routine	Function	Priority Level	Size
P	Synchronization of controller with computer	2	114
Q	System shutdown	NA	30
R	Transformation of controller to Standby	2	70
S	Fixed time controller transition	2	320
T	Fixed time controller timing	2	376
U	Offset correction	2	98
V	Micro loop executive	2	614
W	Signal pattern selection	3	690
X	Semiactuated controller timing and transition	2	350
Y	Start up and data base	NA	18714
MACRO	Macro loop executive	5	168
RTN5	Surveillance Data Computation	5	264
PREDICT	Volume and speed prediction	5	568
RTSND	Real-time subnetwork determination	5	1798
LSTSQS	Network optimization	5	5158
INTFC	Subnetwork interfacing	5	510
TRNPAR	Transition parameter computation	5	296

*Includes initialization data.

2.4 PHILOSOPHY OF THE SECOND GENERATION SOFTWARE

The requirements upon which the second generation control software is based are:

1) Signal light patterns for the traffic network should be optimized on-line as a function of current and predicted traffic conditions.

2) The system should adapt to localized, short-term fluctuations in traffic; however, this adaption should be performed within the progression constraints imposed by item 1).

3) New signal light patterns must be implemented in a non-disruptive manner.

The second generation software meets the above requirements through the following features:

1) A multi-level control approach is used

2) The total network is partitioned into subnetworks in real time.

Using multi-level control permits the complexity of the control algorithm used to be tailored to the situation at hand. For example, at one extreme, marked changes in traffic characteristics will necessitate reoptimization. The algorithm to perform this reoptimization is relatively complex and time consuming. At the other extreme, difficulties caused by relatively small, short-term fluctuations at a given intersection can, in general, be handled with simple algorithms which require little computational time.

Two advantages are gained from partitioning the network into subnetworks. First, because of street geometry and traffic conditions, an optimal solution for a very large grid would tend to disperse delay over the entire network due to the averaging process inherent in the algorithm. Thus, delay in any given subgroup would be larger than if the subgroup were considered independently. Second, the execution time of the network optimization routine is nonlinear with respect to the number of links; thus, it is more efficient from a computer resources standpoint to process the intersections/links in several groups rather than all in one group.

Multi-level control is provided by the MACRO loops which in turn provide strategic and tactical optimization respectively. The MACRO loop is entered once each 5MINCT minutes and optimizes signal settings for an entire subnetwork. Signal patterns for the entire UTCS network are computed in less than 2 minutes.

The UTCS/2GCF Priority Level 5 routines comprise the 2GCF MACRO loop. An overview of the first and second generation software interface is given in the following subsections.

2.5 OVERVIEW OF THE FIRST AND SECOND GENERATION SOFTWARE INTERFACE

Overview flows of the UTCS/2GCF Priority Level 2 and Priority Level 5 loops are given in Figures 1 and 2, respectively. The Critical Intersection Control Routine (Routine V) of the first generation system has replaced Routine LOCAL used in the Assembly language version of UTCS-2GC.

As shown in Figure 2, the Priority Level 5 routines have little interaction with the other four priority levels of the software system.

The method for maintaining traffic signal timing sequences in the first generation system is through the use of interval duration arrays. These arrays contain the time duration of every interval associated with each controller. The interval durations are comprised of fixed intervals and variable intervals. The variable intervals are used to adjust splits and to allow for controller transitions from one signal pattern to another.

Two sets of interval durations are maintained in the first generation software for each controller. These working interval durations are used in the Priority Level 2 loop to step each controller through its proper timing

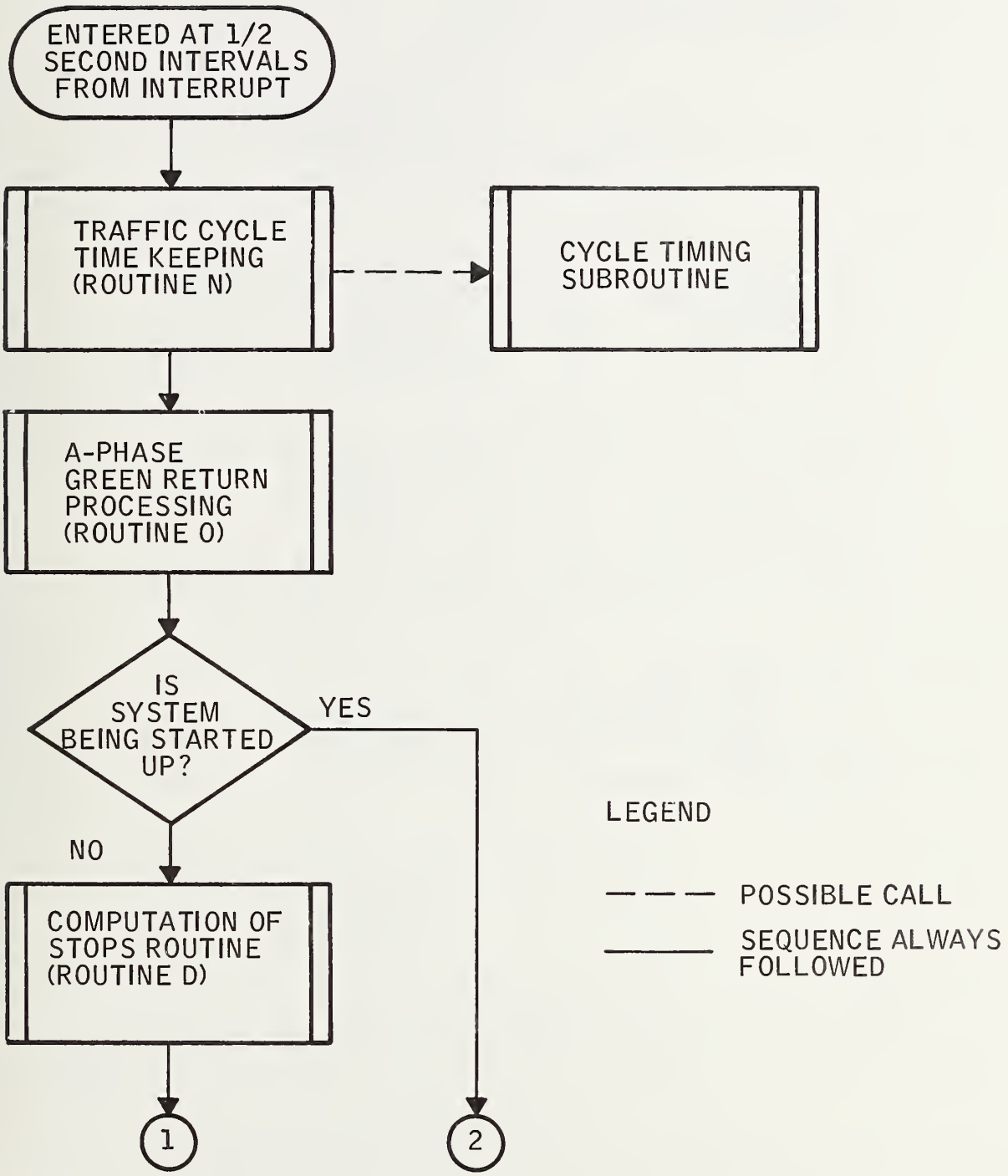


Figure 1. UTCS/2GCF Priority Level Two Routines

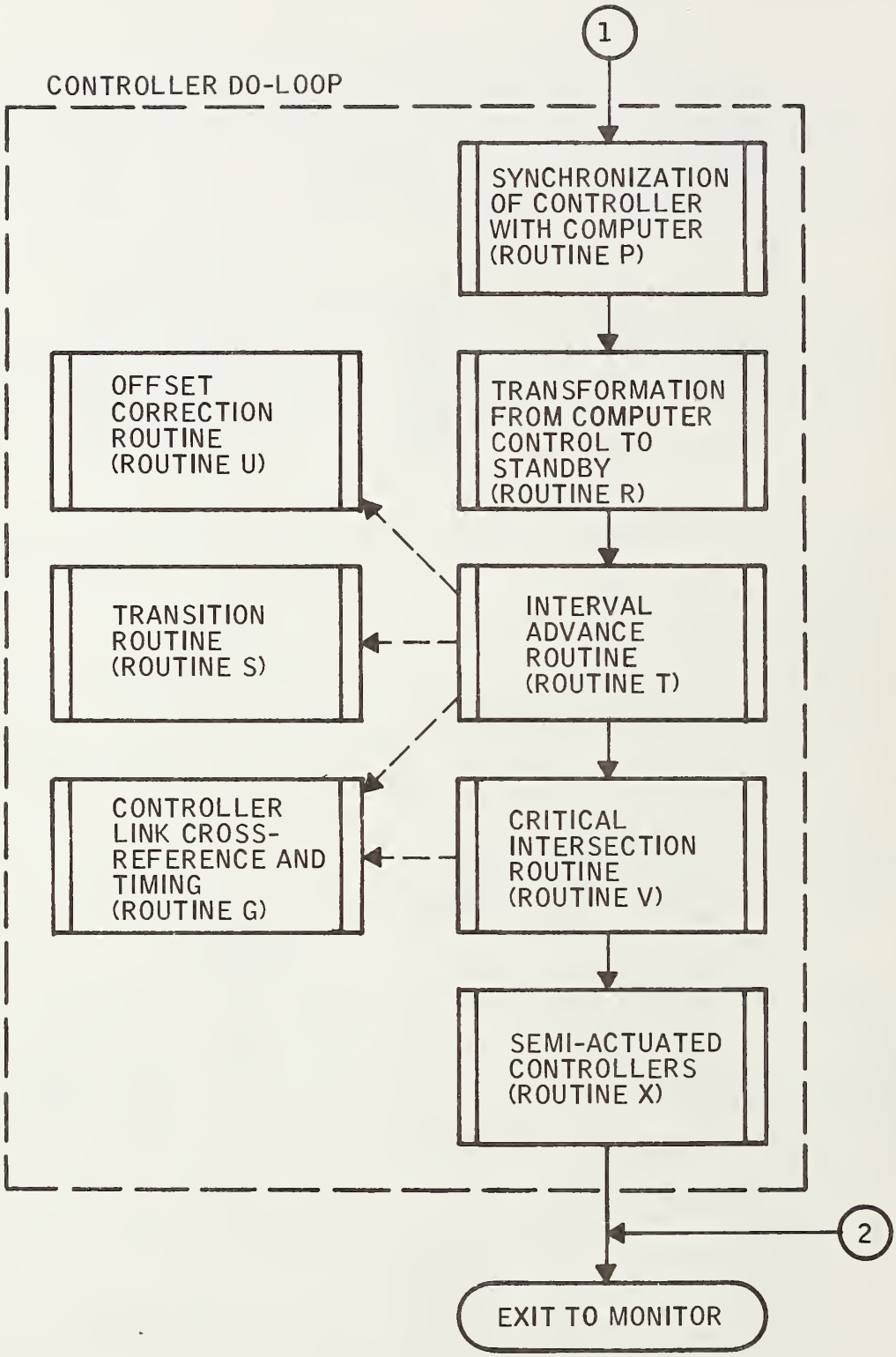

1
CONTROLLER DO-LOOP
SYNCHRONIZATION OF CONTROLLER WITH COMPUTER (ROUTINE P)
OFFSET CORRECTION ROUTINE (ROUTINE U)
TRANSFORMATION FROM COMPUTER CONTROL TO STANDBY (ROUTINE R)
TRANSITION ROUTINE (ROUTINE S)
INTERVAL ADVANCE ROUTINE (ROUTINE T)
CONTROLLER LINK CROSS-REFERENCE AND TIMING (ROUTINE G)
CRITICAL INTERSECTION ROUTINE (ROUTINE V)
SEMI-ACTUATED CONTROLLERS (ROUTINE X)
2
EXIT TO MONITOR

Figure 1. UTCS/2GCF Priority Level Two Routines (Concluded)

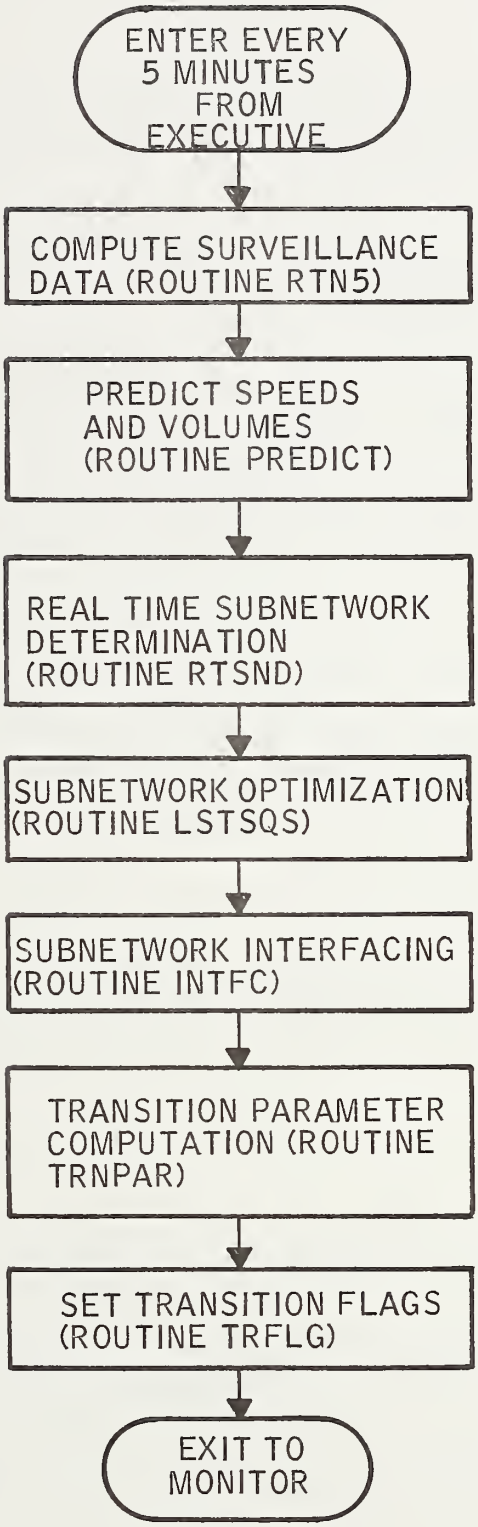

ENTER EVERY 5 MINUTES FROM EXECUTIVE
COMPUTE SURVEILLANCE DATA (ROUTINE RTN5)
PREDICT SPEEDS AND VOLUMES (ROUTINE PREDICT)
REAL TIME SUBNETWORK DETERMINATION (ROUTINE RTSND)
SUBNETWORK OPTIMIZATION (ROUTINE LSTSQS)
SUBNETWORK INTERFACING (ROUTINE INTFC)
TRANSITION PARAMETER COMPUTATION (ROUTINE TRNPAR)
SET TRANSITION FLAGS (ROUTINE TRFLG)
EXIT TO MONITOR

Figure 2. UTCS/2GCF Priority Level Five Routines

sequence. The working interval array is loaded from the entry interval array after the transition from one signal pattern to another is completed.

The entry interval array is loaded from the RAD when a pattern update occurs.

The second generation software must interface with these arrays so that the signals may be controlled. The outputs of the Priority Level 5 loop are offsets, splits, and cycle lengths for each intersection. From these outputs the variable interval durations are computed for each controller. These are obtained by first computing phase durations for each controller by using splits and cycle length. The variable intervals are then computed by subtracting the sum of the fixed intervals in each phase from the computed phase duration. The result is the variable interval duration which is loaded into its proper location in the entry interval array. After the processes have been completed for all controllers, the transition flags are set to transition the controllers to the new pattern.

The net effect of the above processes is to vary the cycle lengths, offsets, and splits through use of the variable intervals. All clearance intervals are maintained as a function of the time-of-day pattern read in from the RAD.

2.6 SECOND GENERATION (FORTRAN) – 2GCF – ROUTINES

The following pages describe in detail each of the routines in the 2GCF/UTCS software. The prescribed format for presenting the routines is followed; however, in some instances all of the information was not applicable and in those cases the paragraph is marked N/A.

2.6.1 ROUTINE A

2.6.1.1 Purpose

The purpose of the UTCS Executive (Routine A) is to control the sequence by which other routines are performed in accordance with predefined assignments of priority and elapsed time. In addition, Routine A performs all multiplexer (MUX) I/O. This routine is coded in assembly language and is machine dependent. The executive for another hardware application must functionally accomplish the tasks described herein.

2.6.1.2 Relationship

The clock interrupt causes this routine to be entered every 1/32 of a second.

2.6.1.3 Assumption

All routines are configured into the system for execution.

2.6.1.4 Approach

Routine A is composed of an Executive Initialization Loop, a Counter Pulse 3 Clock Task, a Main Loop, a Level 3 Loop and an End Action Task. It also schedules the Level 2 Executive, Routine A1, which controls the sequencing of all Priority Level 2 routines.

The Executive Initialization Loop is entered directly from Routine Y after it has completed its required start-up tasks. The loop sets up the priority structure of the program and allows real time processing. The loop

connects tasks directly or centrally to interrupts. By connecting tasks directly, the monitor is bypassed and the user must save the environment. When tasks are connected centrally, the monitor will save the environment at the expense of slower reaction time than that of direct connection. It should be noted that the internal clock interrupt (location X'5A') has a higher priority than those of the external interrupts whose priority order is listed in Table 1.

When the 1/32 of a second mark occurs, the internal clock interrupt causes the monitor to transfer control to the Counter Pulse 3 clock task. This task resets the clock counter value to 250 (an internal clock pulse decrements this counter 8000 times per second resulting in a clock interrupt every 1/32 of a second), triggers the Priority Level 1 interrupt (location X'62'), releases the internal clock interrupt (location X'5A') and exits to the monitor. The monitor then transfers control to the Main Loop of the UTCS Executive Routine.

The Main loop updates the real time clock (RTC), sets half-second and one second flags, and decrements several scheduler clocks once per second. When a scheduler clock has counted down to zero, its corresponding Priority Level 3 routine is scheduled by setting its activity bit in the appropriate word in the Master Activity Scan Table (MAST). The next task is to decrement the Detector Buffer Pointer (DBP) and perform all multiplexer I/O. The Detector Buffer Pointer is used to point to the vehicle detector array (P1, P2, P3, or P4) that is to be filled for use in the detector processing algorithm used by Routine B. After multiplexer I/O is performed, the Priority Level 1 routines (Routines B and C) are performed; if a half-second mark is encountered, the Priority Level 2 interrupt (location X'63') is triggered and the Priority Level 3 interrupt (location X'64') is triggered. Then the Priority Level 1 interrupt (location X'62') is released, and control is returned to the monitor.

If the Priority Level 2 interrupt is the highest interrupt active, control is given by the monitor to the Priority Level 2 Executive, Routine A1. If the Priority Level 3 interrupt is the highest interrupt active, control is given by the monitor to the Level 3 loop. The Level 3 loop controls the execution of the Level 3 routines, whose order of priority is Routine M, J, K, E, H, W, Q, and I. Upon entry, the Level 3 loop scans the Master Activity Scan Table (MAST) from top to bottom for a word having an activity bit (A) present and a Service bit (S) absent. If no word can be found, the Priority Level 3 interrupt (location X'64') is released and control is returned to the monitor. If a word is found, the "A" bit is reset and the control bit (C) is set in MAST, and the corresponding Priority Level 3 routine is executed. The last step in this routine is to reset its "C" in MAST and return control to the Level 3 loop which scans MAST from the top of the table again. If a routine suspends itself while waiting for I/O completion, it sets its "S" bit and returns control to the top of the Level 3 loop for another scan of MAST. Upon completion of I/O operation, control is eventually returned to the routine via the End Action Task and the Level 3 loop. Note that if a routine is scheduled (that is, its "A" bit is set in MAST), while waiting for I/O service (that is, its "S" bit is set in MAST), it is not given control until the completion of I/O operation. The only Priority Level 3 routines that may wait for I/O servicing are Routines H, I, and W.

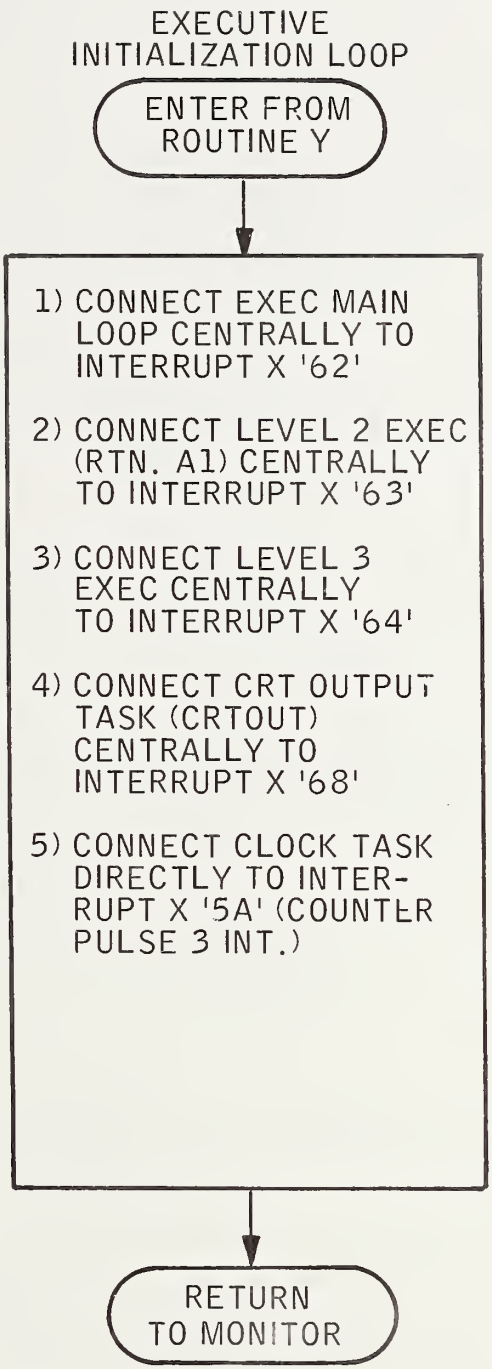
To support 2GC routines interrupt X'69' is connected during initialization. This interrupt transfers to the Level 5 control task in Routine A which then calls the Level 5 executive routine MACRO.

Code is present in the main loop of Routine A, to decrement and test the software counter 5MINCT. When this counter decrements to zero, it is reinitialized to the Level 5 execution frequency, OPTIME, and the 5MINF flag is set to indicate to the one-half second loop of Routine A that the Priority Level 5 interrupt, X'69', is to be triggered.

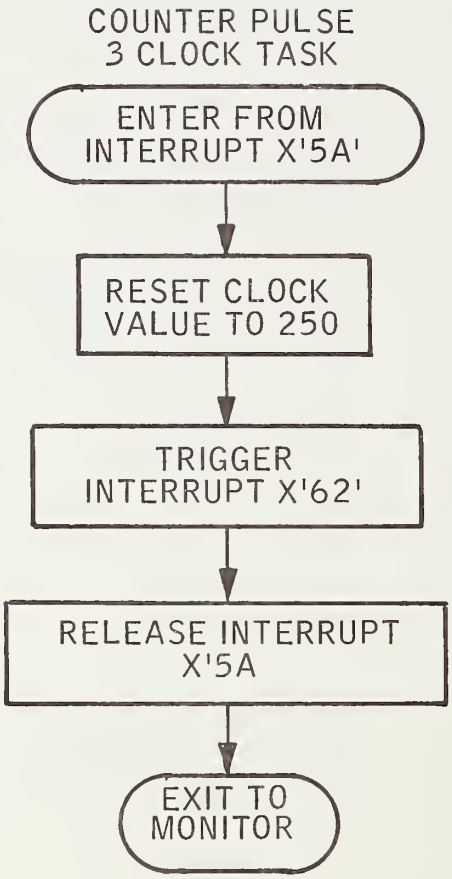
A test on the Routine Q Scheduled Flag, 5END, is in the one-half second loop of Routine A. When this flag is set, the 5END1 flag is set to indicate to the Level 5 executive MACRO, the predictor performance report is to be printed.

2.6.1.5 Listing

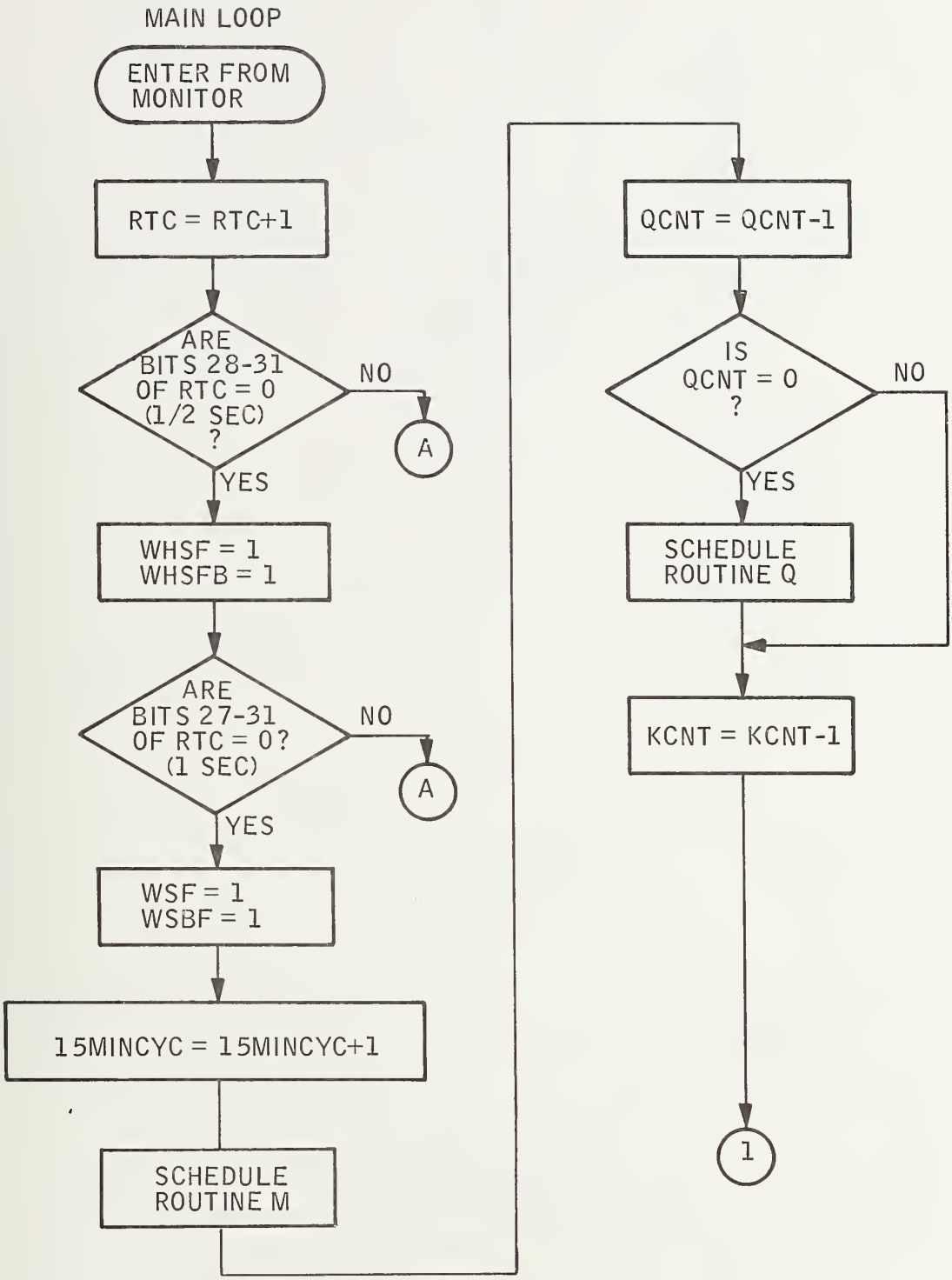
See Volume III, 2GCF Routine Listings.



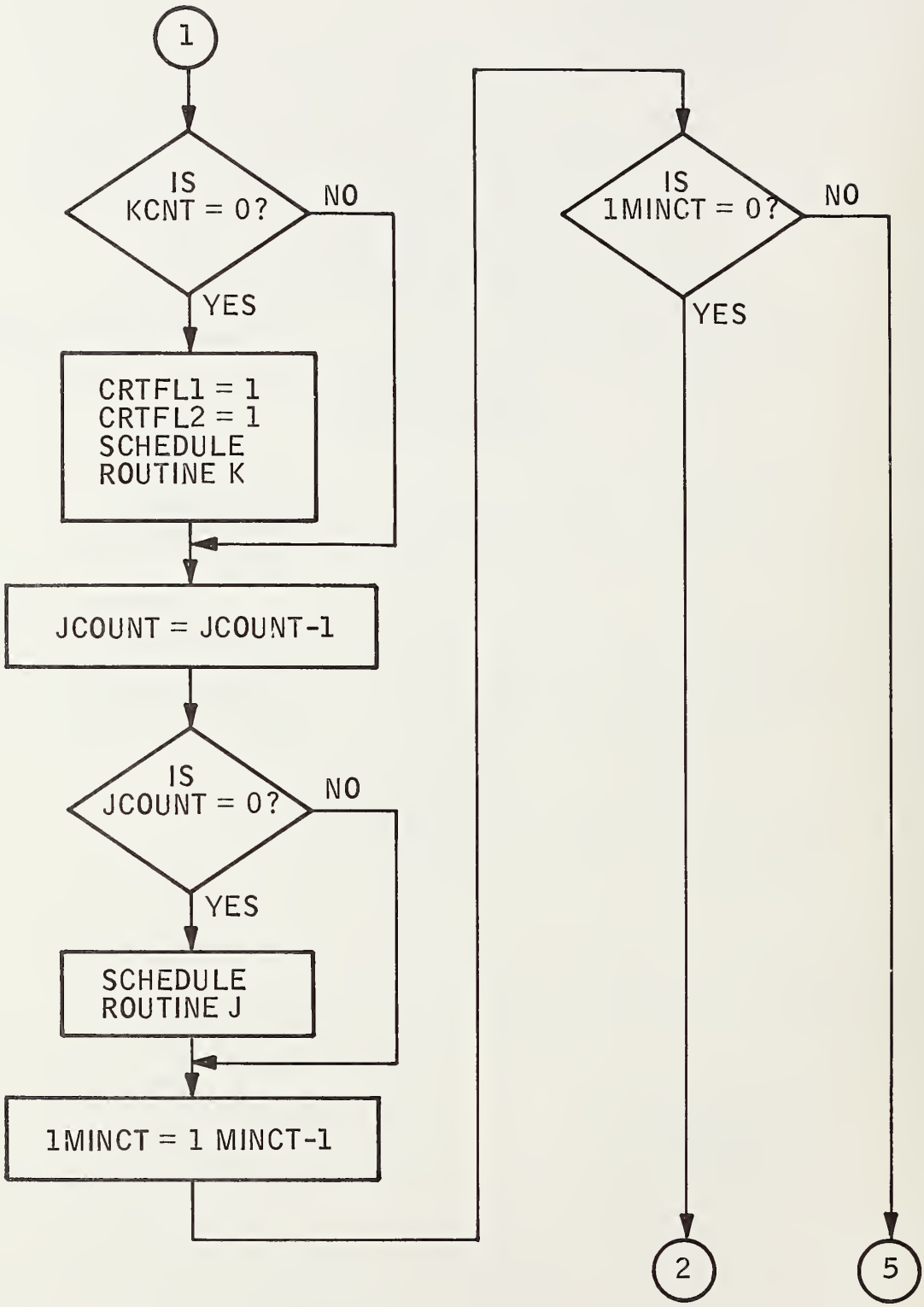
Routine A (Executive Initialization Loop)



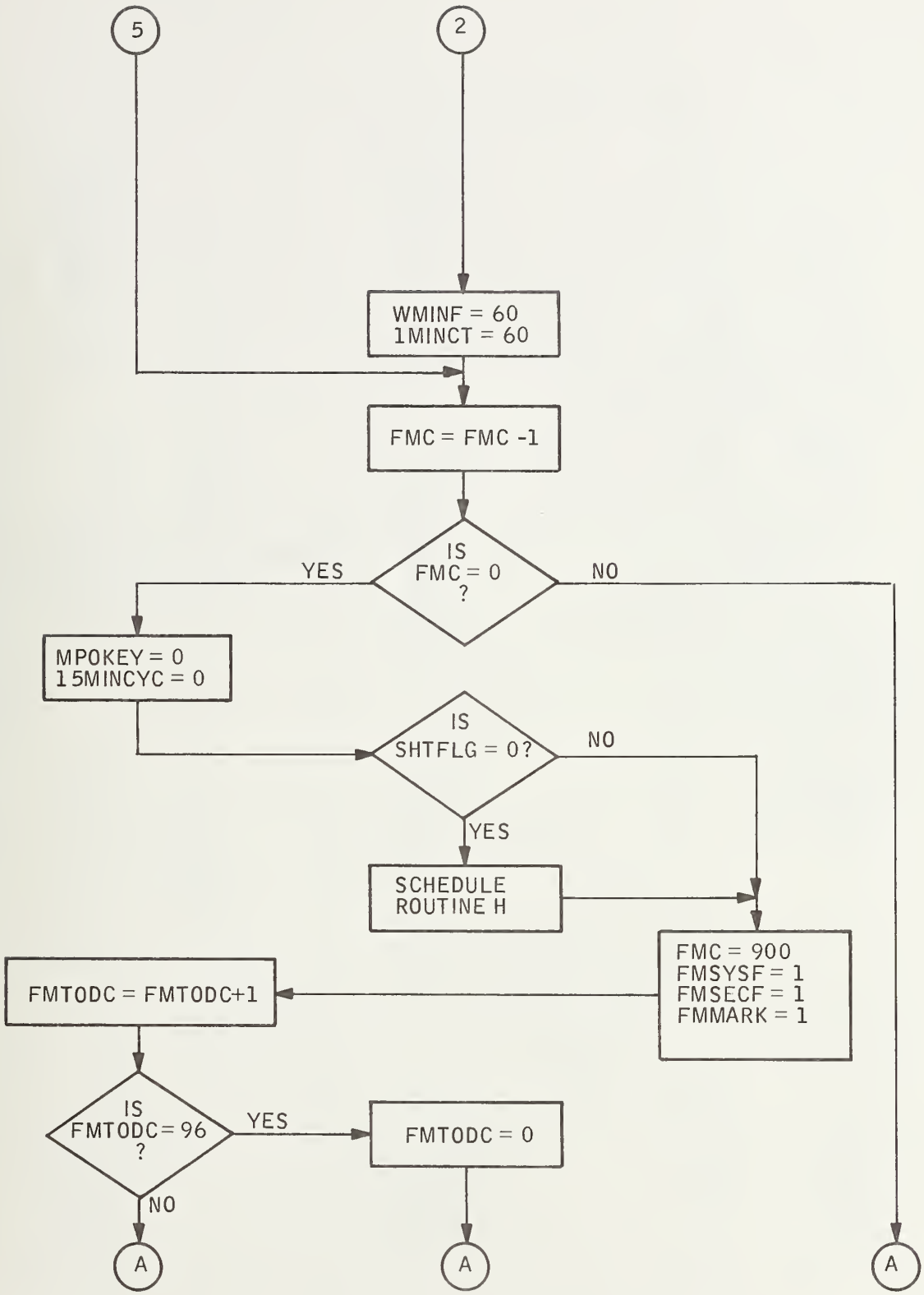
Routine A (Counter Pulse 3 Clock Task)



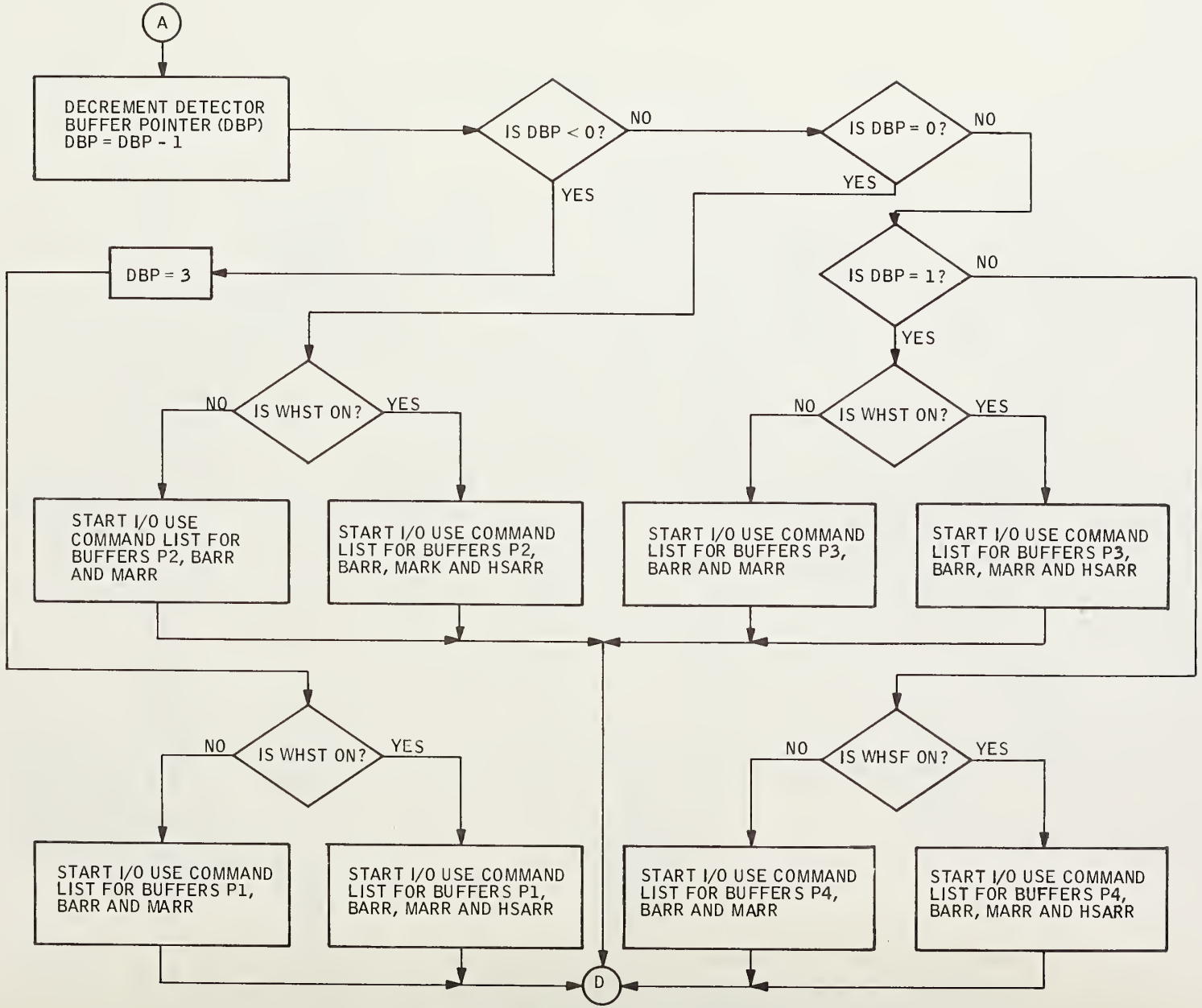
Routine A (Main Loop)



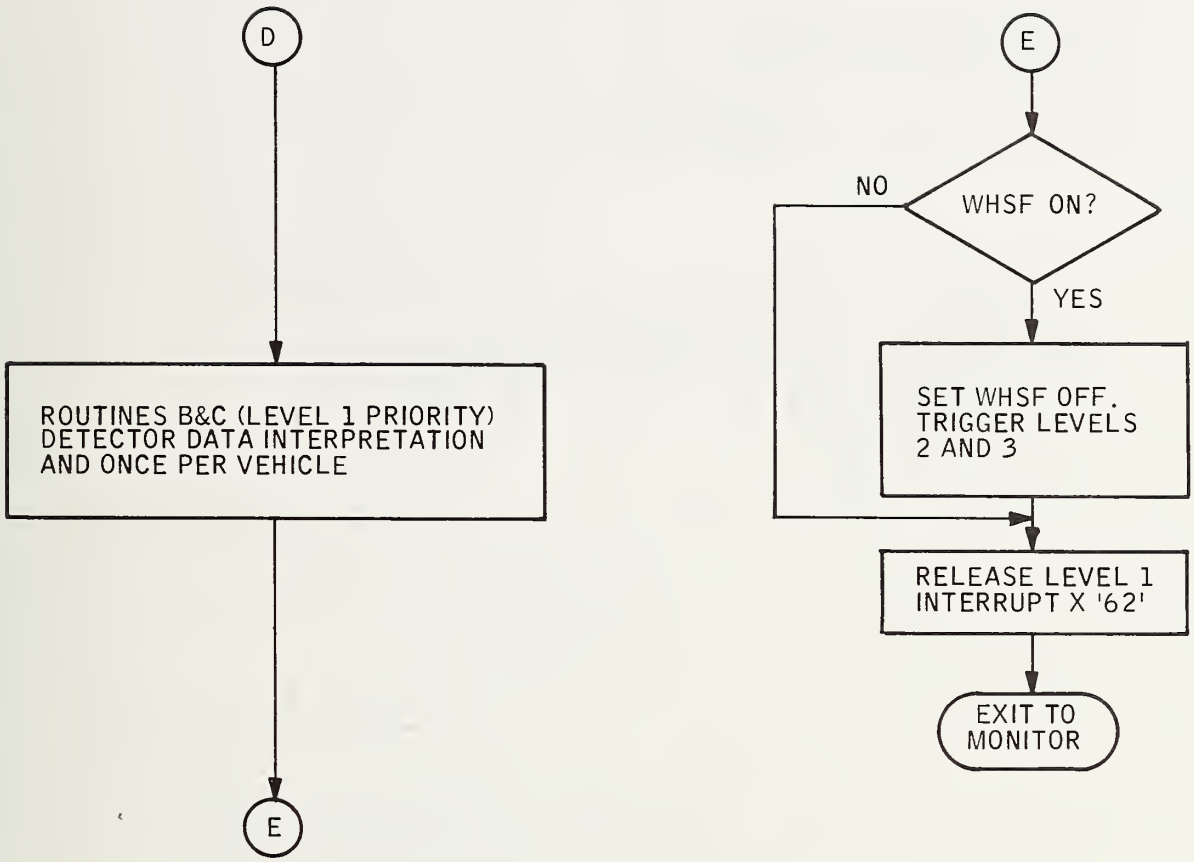
Routine A (Main Loop) (Continued)



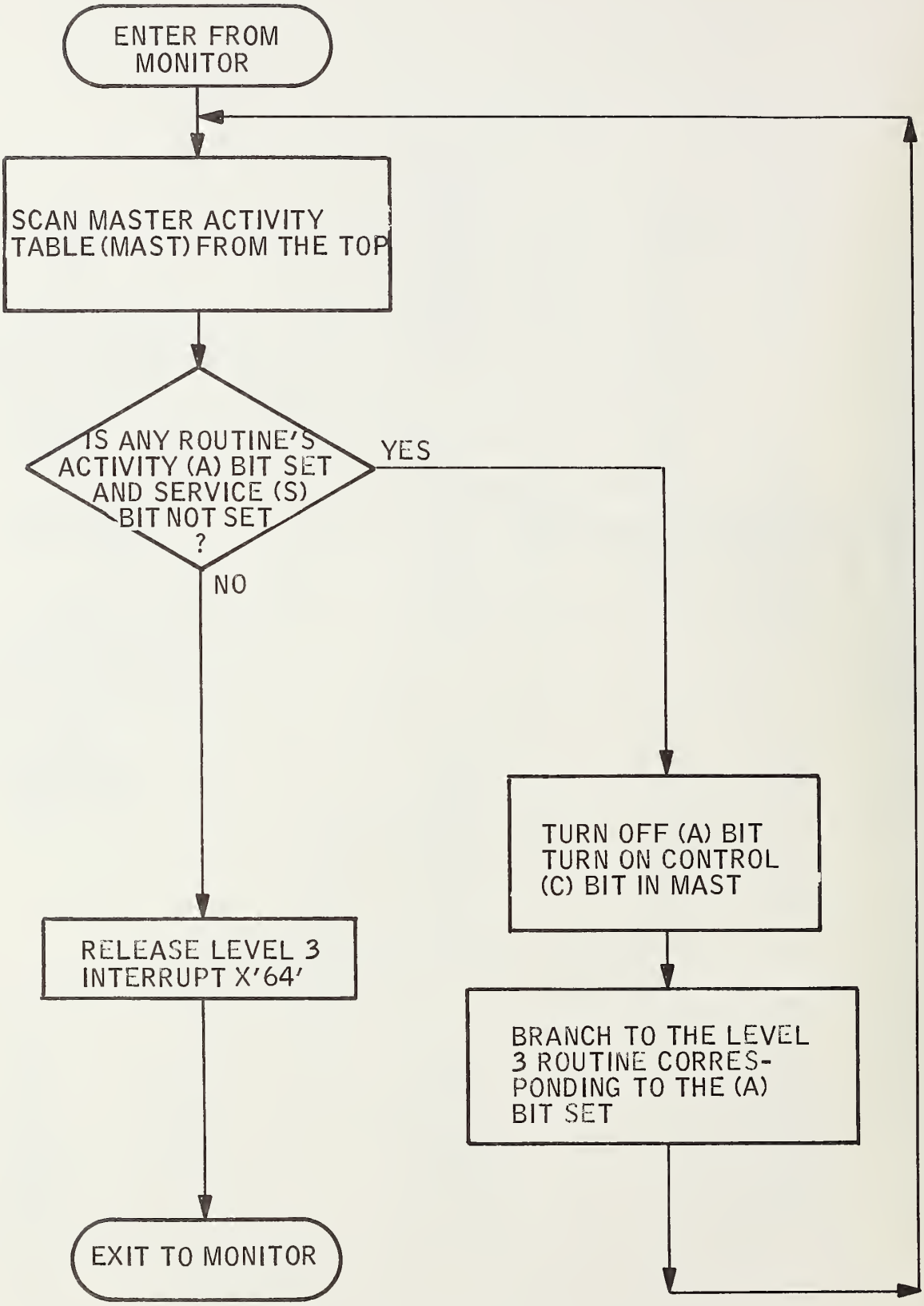
Routine A (Main Loop) (Continued)


A
DECREMENT DETECTOR BUFFER POINTER (DBP)
DBP = DBP - 1
IS DBP < 0?
NO
YES
IS DBP = 0?
NO
YES
DBP = 3
IS DBP = 1?
NO
YES
NO
IS WHST ON?
YES
NO
IS WHST ON?
YES
START I/O USE COMMAND LIST FOR BUFFERS P2, BARR AND MARR
START I/O USE COMMAND LIST FOR BUFFERS P2, BARR, MARK AND HSARR
START I/O USE COMMAND LIST FOR BUFFERS P3, BARR AND MARR
START I/O USE COMMAND LIST FOR BUFFERS P3, BARR, MARR AND HSARR
NO
IS WHST ON?
YES
NO
IS WHSF ON?
YES
START I/O USE COMMAND LIST FOR BUFFERS P1, BARR AND MARR
START I/O USE COMMAND LIST FOR BUFFERS P1, BARR, MARR AND HSARR
START I/O USE COMMAND LIST FOR BUFFERS P4, BARR AND MARR
START I/O USE COMMAND LIST FOR BUFFERS P4, BARR, MARR AND HSARR
D

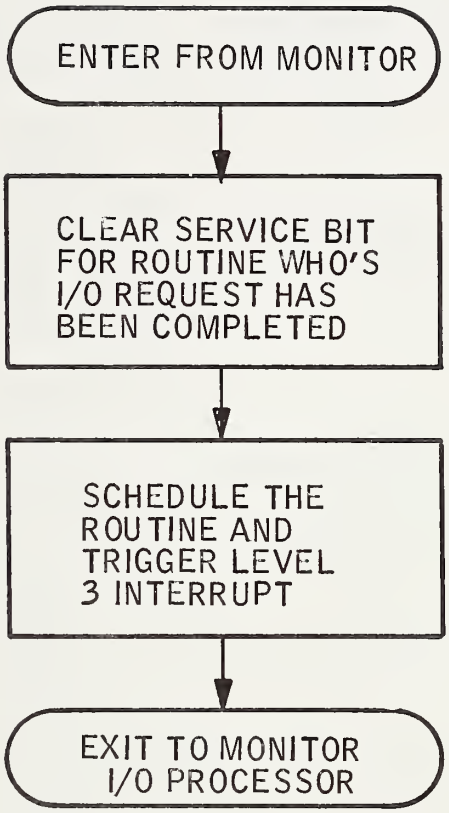
Routine A (Main Loop) (Continued)



Routine A (Main Loop) (Concluded)


ENTER FROM MONITOR
SCAN MASTER ACTIVITY TABLE (MAST) FROM THE TOP
IS ANY ROUTINE'S ACTIVITY (A) BIT SET AND SERVICE (S) BIT NOT SET ?
YES
NO
TURN OFF (A) BIT TURN ON CONTROL (C) BIT IN MAST
BRANCH TO THE LEVEL 3 ROUTINE CORRES-PONDING TO THE (A) BIT SET
RELEASE LEVEL 3 INTERRUPT X'64'
EXIT TO MONITOR

Routine A (Level 3 Loop)


ENTER FROM MONITOR
CLEAR SERVICE BIT FOR ROUTINE WHO'S I/O REQUEST HAS BEEN COMPLETED
SCHEDULE THE ROUTINE AND TRIGGER LEVEL 3 INTERRUPT
EXIT TO MONITOR I/O PROCESSOR

Routine A (End Action Task)

2.6.2 SUBROUTINE A5

2.6.2.1 Purpose

Executive routine for Level 5 activity.

2.6.2.2 Relationship

Subroutine A5 is called from Routine A and occurs every 5MINCT seconds.

2.6.2.3 Assumption

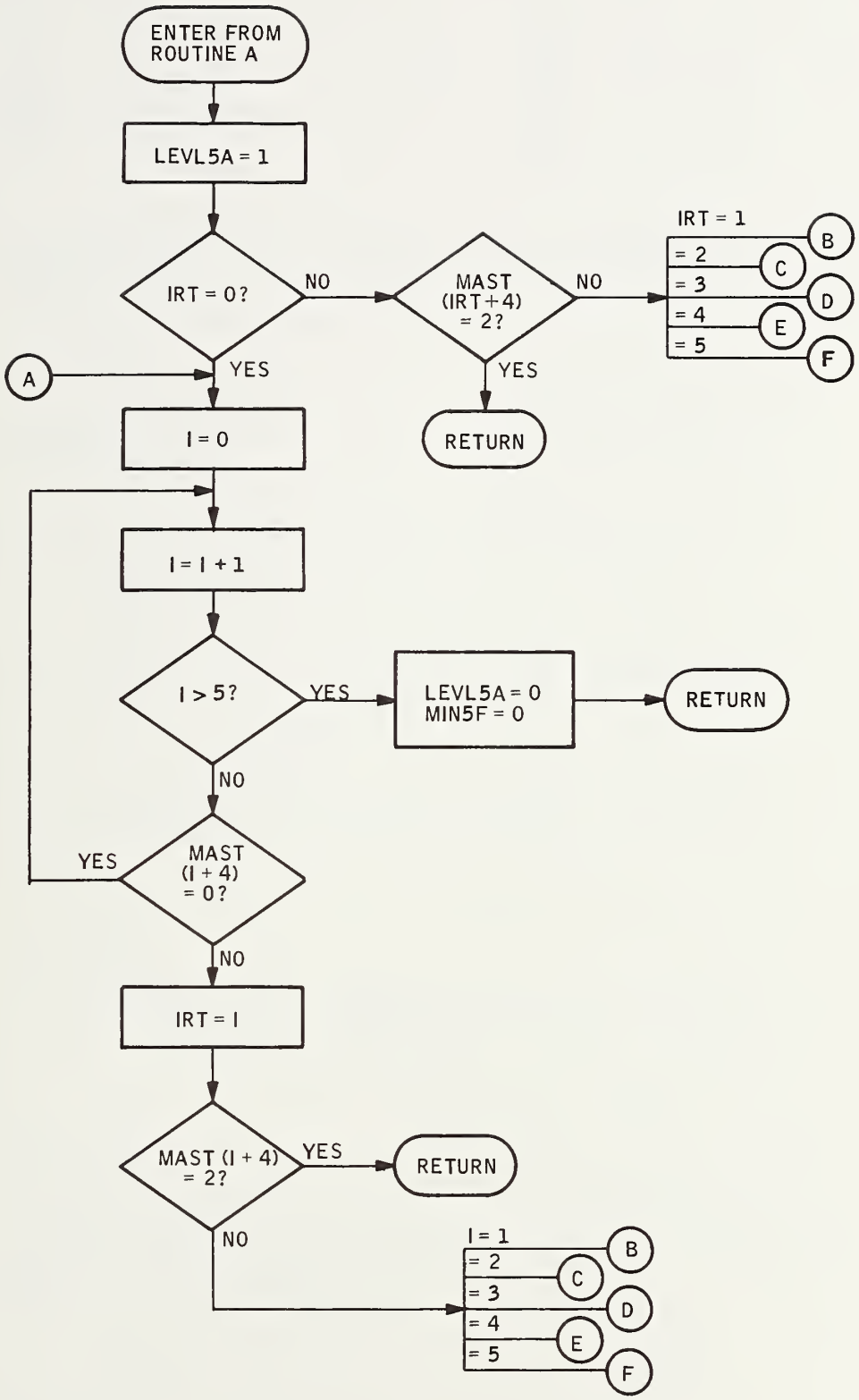
None

2.6.2.4 Approach

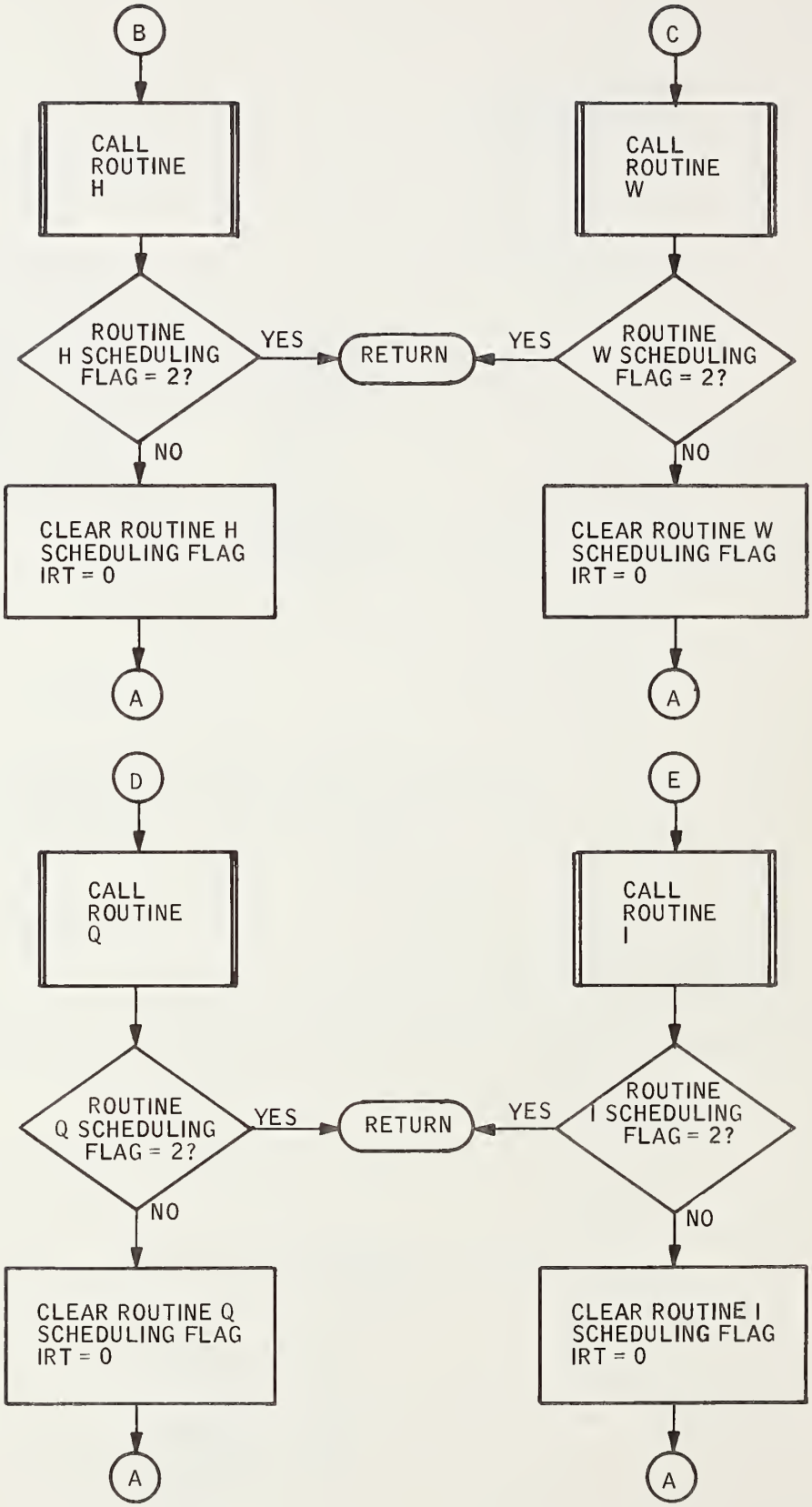
Subroutine A5 examines the MAST array to determine if routines H, MACRO, O, or W have been scheduled. A5 then calls the scheduled routines.

2.6.2.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine A5



Subroutine A5 (Concluded)

2.6.3 SUBROUTINE CHECK

2.6.3.1 Purpose

To return state of CRT from RBM.

2.6.3.2 Relationship

This subroutine is called from Subroutine CRTOUT by:

```
CALL CHECK (A, B)
```

where

A specifies the byte to be retrieved from the STATE array.

B returns the byte specified.

Subroutine CHECK returns to the calling routine.

2.6.3.3 Assumption

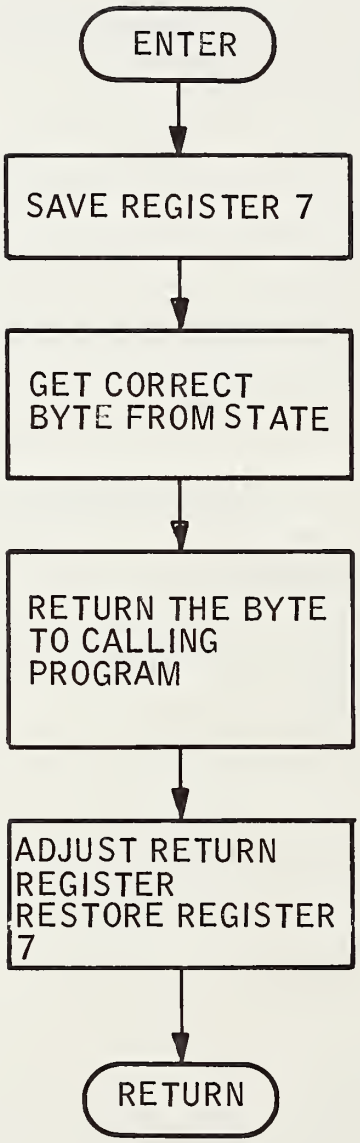
None.

2.6.3.4 Approach

Retrieve the byte specified by the A argument from the STATE array, return it to the calling routine as argument B.

2.6.3.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine CHECK

2.6.4 SUBROUTINE CRTOUT

2.6.4.1 Purpose

Provide interface between CRT formatting routine (RTNK) and CRT DEVICE.

2.6.4.2 Relationship

This subroutine is called by Routine A and returns to the calling routine.

This subroutine calls subroutines: CSET, CSTART, CHECK, CWRITE, and EXIT.

2.6.4.3 Assumption

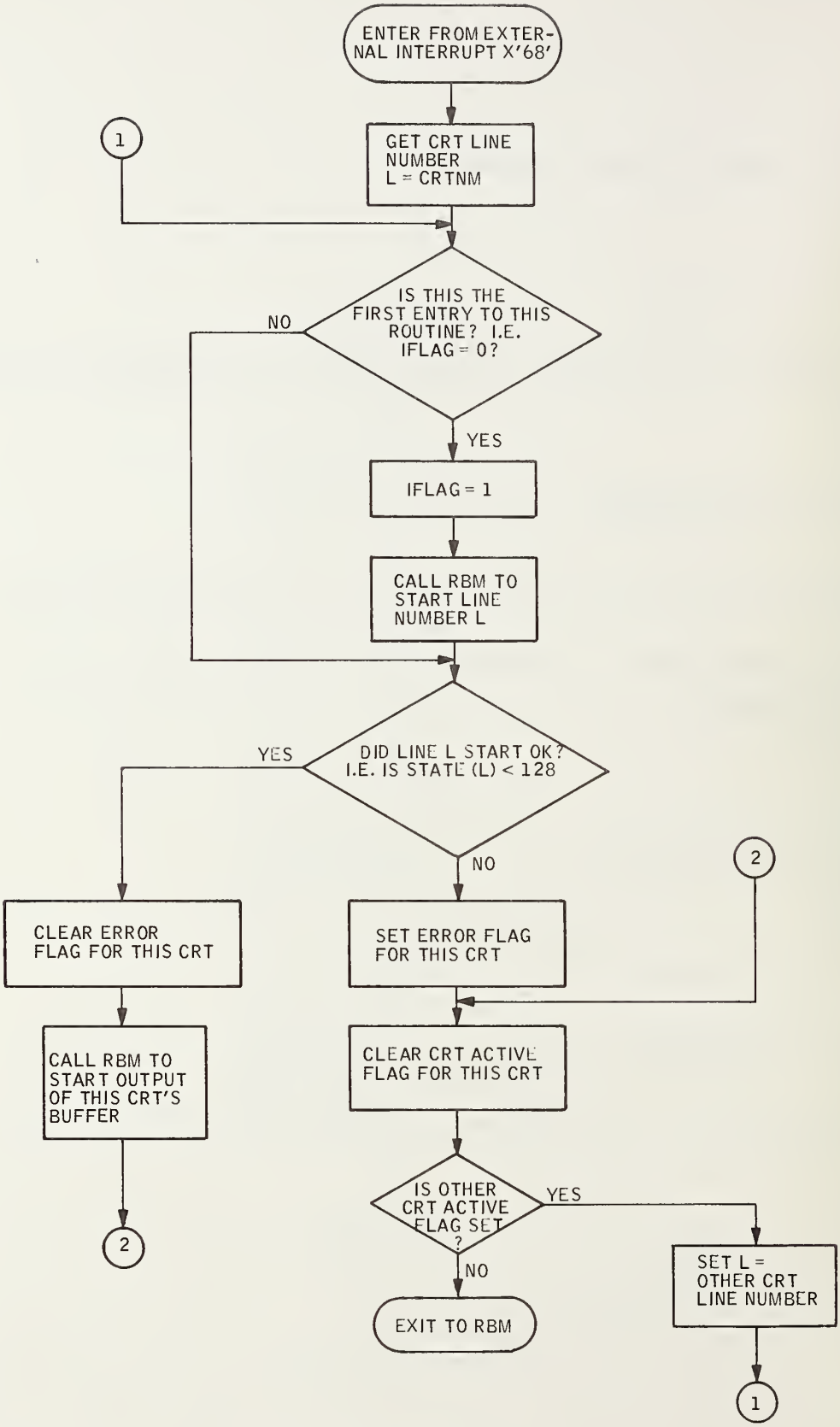
None.

2.6.4.4 Approach

Polls two CRTs and, if the line is cleared, directs CRT output.

2.6.4.5 Listing

See Volume III, 2GCF Routine Listings.


ENTER FROM EXTERNAL INTERRUPT X'68'
1
GET CRT LINE NUMBER L = CRTNM
IS THIS THE FIRST ENTRY TO THIS ROUTINE? I.E. IFLAG = 0?
NO
YES
IFLAG = 1
CALL RBM TO START LINE NUMBER L
DID LINE L START OK? I.E. IS STATE (L) < 128
YES
NO
2
CLEAR ERROR FLAG FOR THIS CRT
SET ERROR FLAG FOR THIS CRT
CALL RBM TO START OUTPUT OF THIS CRT'S BUFFER
CLEAR CRT ACTIVE FLAG FOR THIS CRT
2
IS OTHER CRT ACTIVE FLAG SET ?
YES
NO
SET L = OTHER CRT LINE NUMBER
EXIT TO RBM
1

Subroutine CRTOUT

2.6.5 ROUTINE A1

2.6.5.1 Purpose

This routine controls the execution of the controller do-loop by scheduling the routines in the loop when their functions are required.

2.6.5.2 Relationship

This routine is entered once every second. It represents the control routine for Level 2 and calls Routines O, P, R, T, V, and X. It is entered from Routine A every second and exits to Routine A. The coding of Routine N is currently included in Routine A1 and a call to Routine N is not made.

2.6.5.3 Assumption

None.

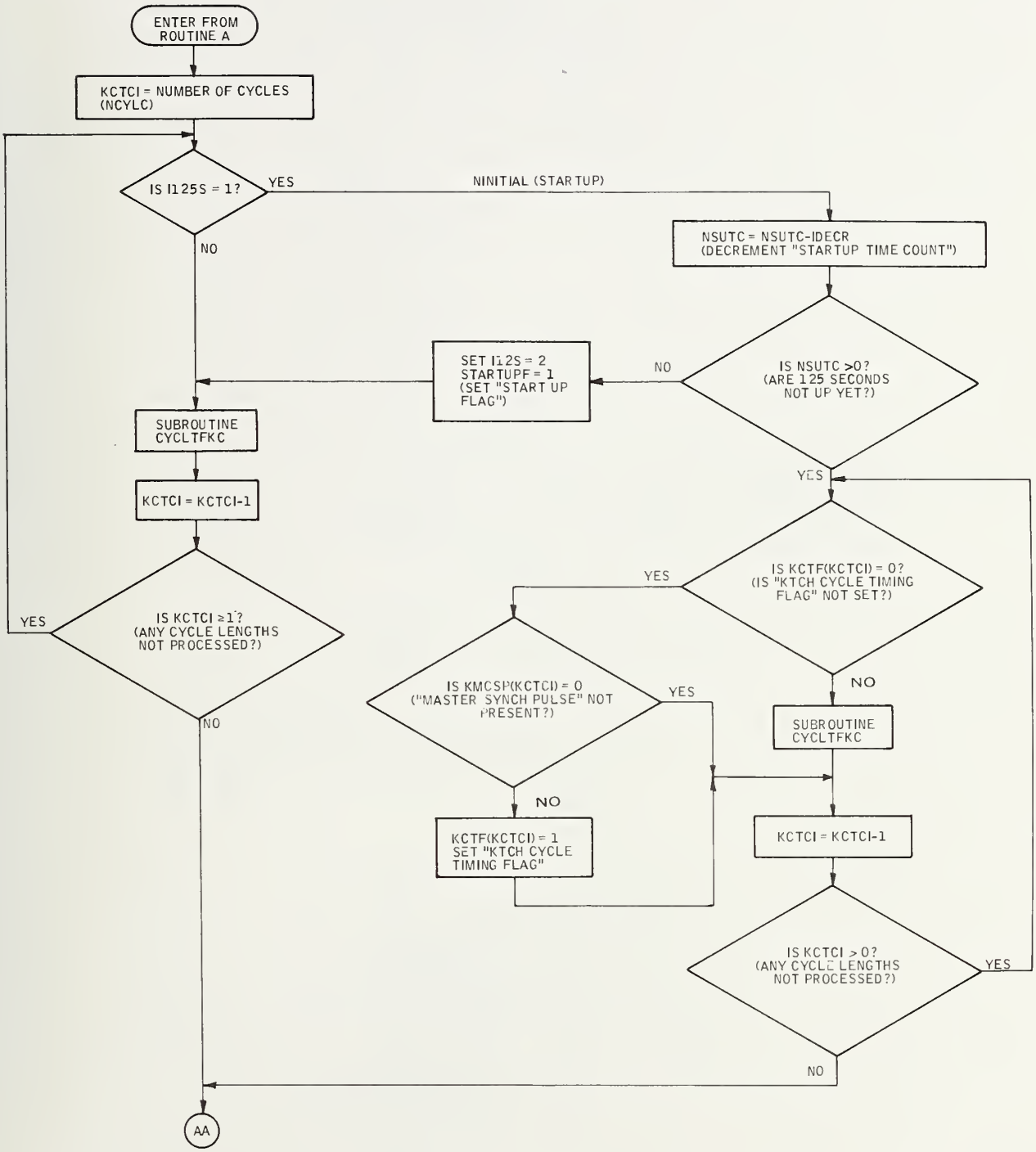
2.6.5.4 Approach

The Level 2 Executive Routine decides whether a Priority Level 2 routine is to be entered. If system parameters and/or flags indicate that the routine is required, it is scheduled, otherwise it is not entered for that pass through the loop. The loop is executed completely IL2 (currently 4) times. During each pass, a scheduled routine handles 32 controllers. Before each pass, the Level 2 Executive calls the unpack subroutine UPBL2 to unpack the bit arrays for 32 controllers. At the finish of the loop, subroutine PKBL2 is called to pack those bit arrays that may have changed.

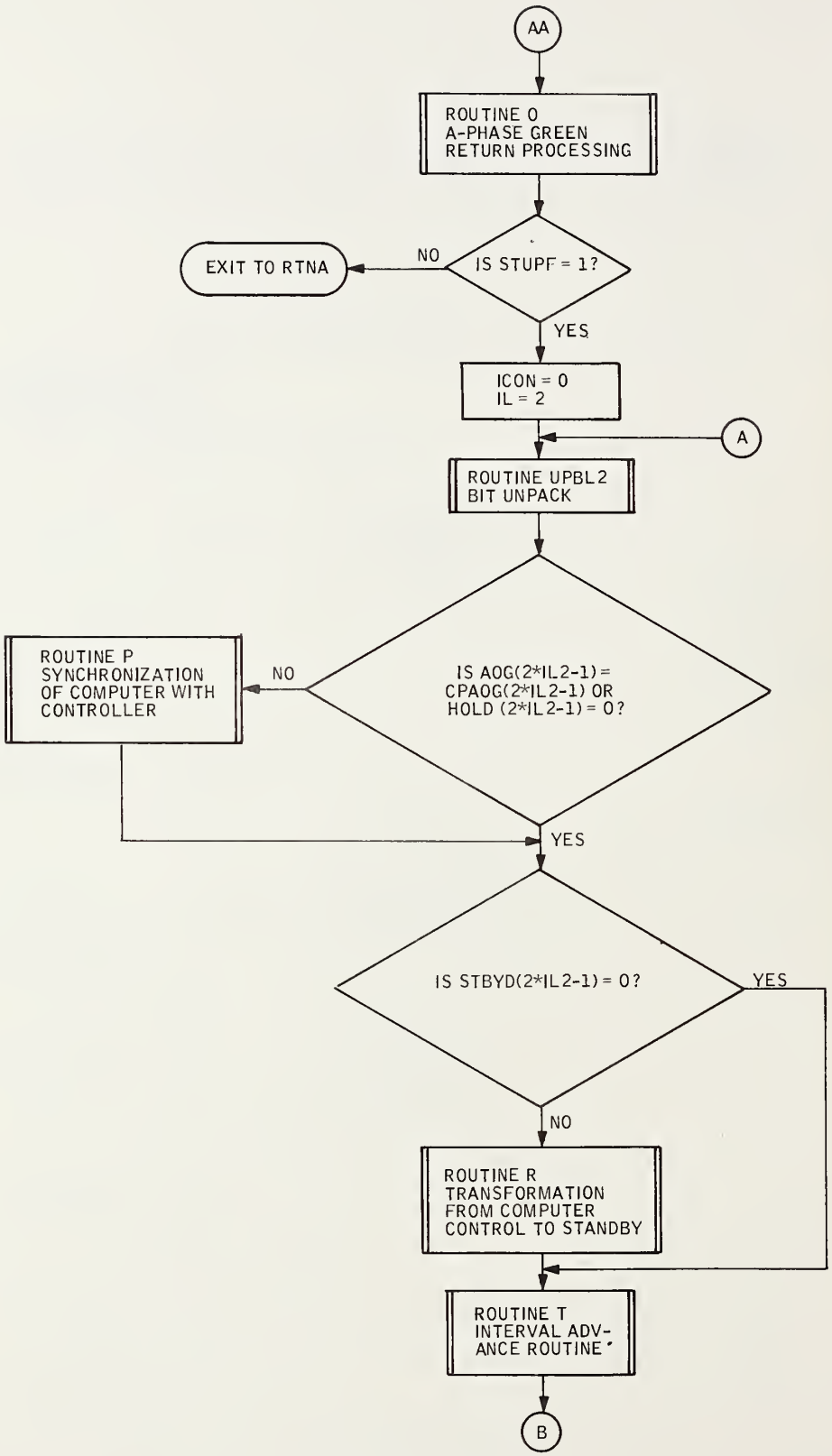
The Level 2 Executive routine also supplies common inputs to the routines of the loop, such as the first controller number (ICON) currently being processed.

2.6.5.5 Listing

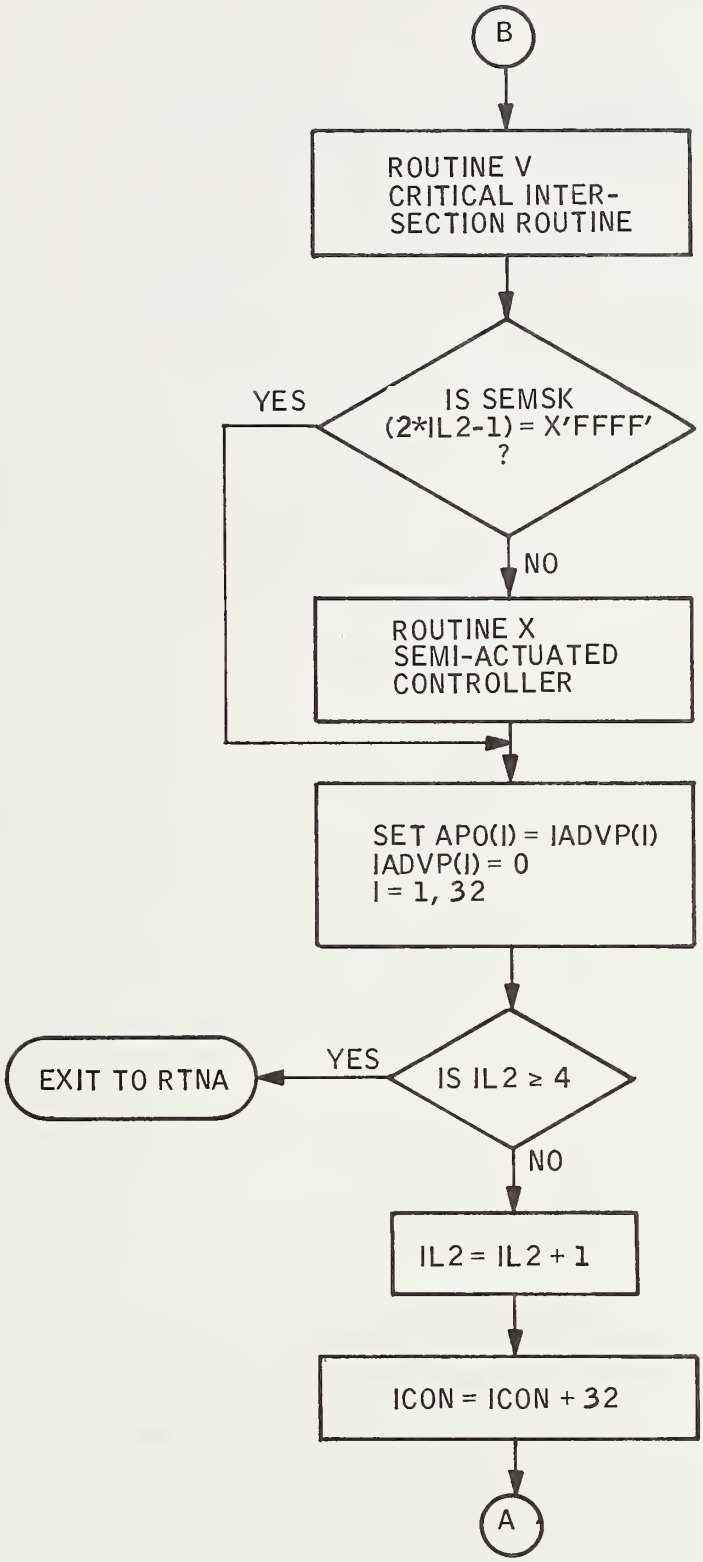
See Volume III, 2GCF Routine Listings.


ENTER FROM ROUTINE A
KCTCI = NUMBER OF CYCLES (NCYLC)
IS I125S = 1?
YES
NO
NINITIAL (STARTUP)
NSUTC = NSUTC-IDECR (DECREMENT "STARTUP TIME COUNT")
IS NSUTC >0? (ARE 125 SECONDS NOT UP YET?)
NO
SET I125 = 2
STARTUPF = 1 (SET "START UP FLAG")
SUBROUTINE CYCLTFKC
KCTCI = KCTCI-1
IS KCTCI ≥1? (ANY CYCLE LENGTHS NOT PROCESSED?)
YES
NO
YES
IS KCTF(KCTCI) = 0? (IS "KTCH CYCLE TIMING FLAG" NOT SET?)
YES
NO
IS KMCSP(KCTCI) = 0 ("MASTER SYNCH PULSE" NOT PRESENT?)
YES
NO
KCTF(KCTCI) = 1 SET "KTCH CYCLE TIMING FLAG"
SUBROUTINE CYCLTFKC
KCTCI = KCTCI-1
IS KCTCI > 0? (ANY CYCLE LENGTHS NOT PROCESSED?)
YES
NO
AA

Routine A1



Routine A1 (Continued)



Routine A1 (Concluded)

2.6.6 SUBROUTINE BUFFERIN/OUT

2.6.6.1 Purpose

Input and output of a buffer.

2.6.6.2 Relationship

This subroutine is called from subroutines PREDICT and PRPRED by:

```
CALL BUFFERIN (CH, F, BUF, L, RS, NT)
```

where:

CH	=	I/O channel number
F	=	format (binary or BCD)
BUF	=	the array to be transferred
L	=	the length of array BUF (in bytes)
RS	=	return status. (Was transfer successful?)
NT	=	number of bytes transferred.

2.6.6.3 Assumption

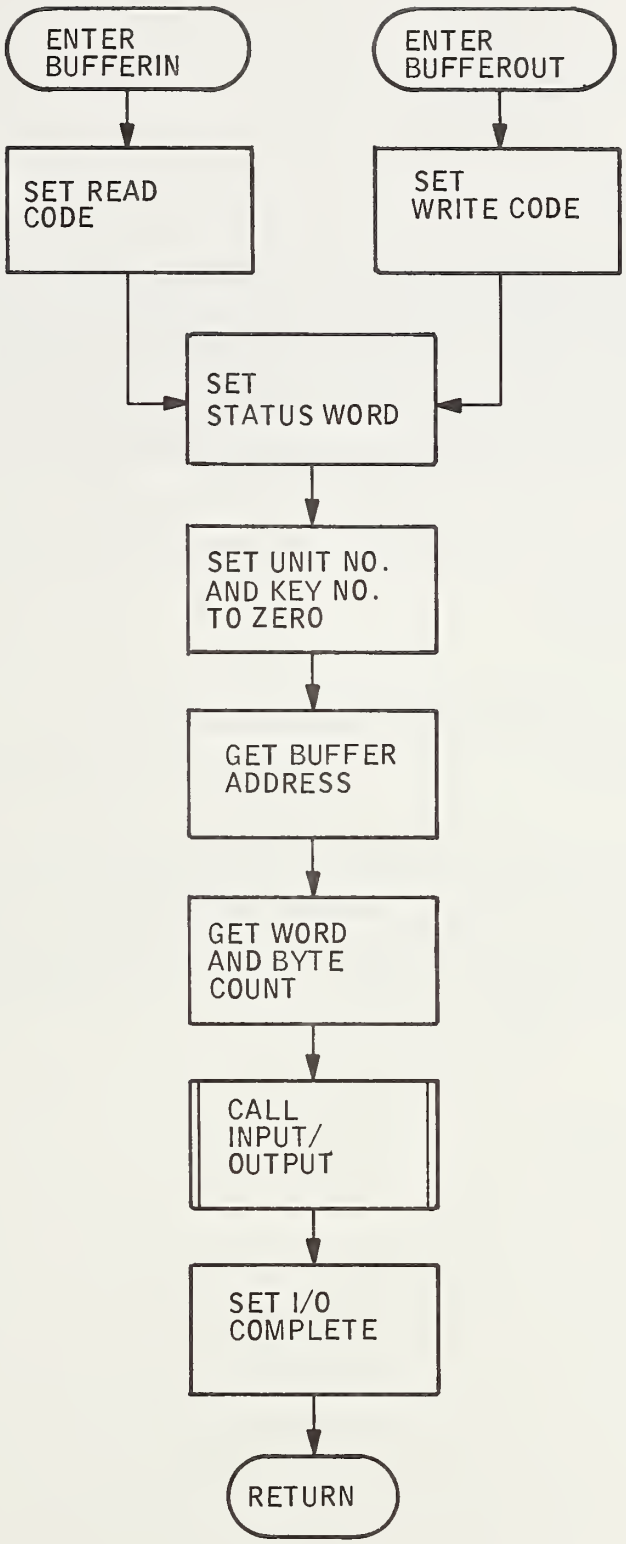
None.

2.6.6.4 Approach

Subroutine BUFFERIN and BUFFEROUT provide two different entry points to the same routines. They differ only in that BUFFERIN sets the read code, BUFFEROUT the write code. The address with the data buffer to be used along with the byte count is then fetched and the system I/O routine called. The subroutine then returns to the calling routine.

2.6.6.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine BUFFERIN/OUT

2.6.7 SUBROUTINE PKBL2

2.6.7.1 Purpose

Subroutine PKBL2 packs 32 values of bit data of the pertinent bit arrays which correspond to the current 32 controllers being processed. It also packs certain byte arrays that are used in more than two Level 2 routines, so to alleviate constant unpacking and packing of these particular byte arrays.

2.6.7.2 Relationship

This subroutine is called from Routine A1 by:

```
CALL PKBL2
```

This subroutine is entered once per second for each group of 32 controllers. For 124 controllers, it would be entered four times. The subroutine is part of the Level 2 controller Do-Loop. It is the last routine called in this Do-Loop and exits to Routine A1.

2.6.7.3 Assumption

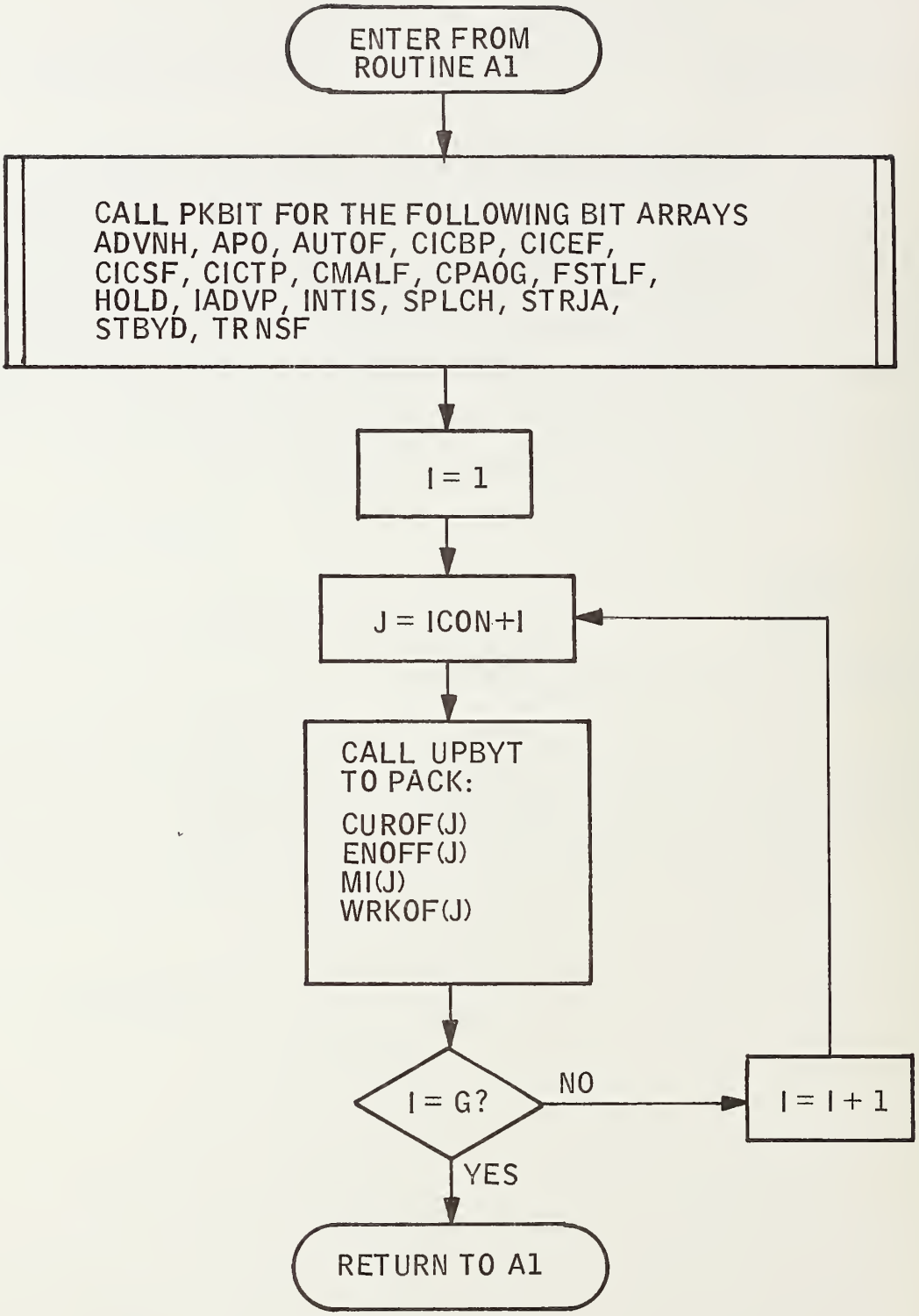
None.

2.6.7.4 Approach

The common blocks that contain the packed data required for Level 2 routines are referenced in this program as well as the common blocks BITL2 and BYTL2 which contain the unpacked data. BITL2 and BYTL2 are referenced by the Level 2 routines and are in FORTRAN accessible word format. For each bit array required by the Level 2 routines, a call is made to PKBIT which packs 32 bits starting an index corresponding to the current controller being processed. For each byte array required, a call to PKBYT is made to pack the byte data associated with the current 32 controllers.

2.6.7.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine PKBL2

2.6.8 SUBROUTINE UPBL2

2.6.8.1 Purpose

Subroutine UPBL2 unpacks 32 values of bit data corresponding to the current 32 controllers being processed. It also unpacks certain byte arrays that are used in more than two routines, so that constant unpacking and packing of these byte arrays is not required.

2.6.8.2 Relationship

This subroutine is called from Routine A1 by:

```
CALL UPBL2
```

Subroutine UPBL2 is entered once per second for each group of 32 controllers. For 124 controllers it would be entered four times. The subroutine is part of the Level 2 controller Do-Loop. It is the first subroutine called in this Do-Loop and exits to Routine A1.

2.6.8.3 Assumption

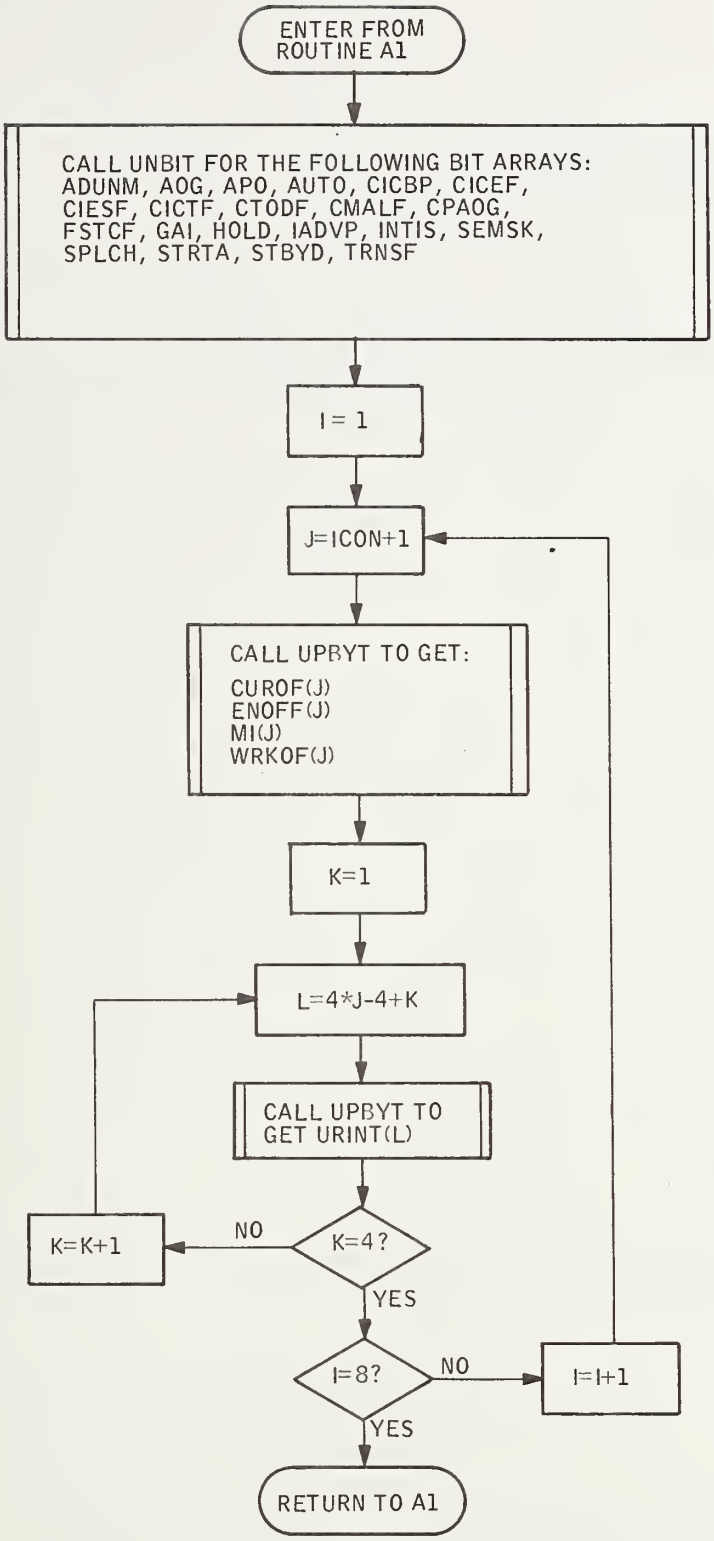
None.

2.6.8.4 Approach

The common blocks that contain the packed data required for Level 2 routines are referenced in this subroutine as well as the common blocks BITL2 and BYTL2 which will contain the unpacked data. BITL2 and BYTL2 are referenced by the Level 2 routines and are in FORTRAN accessible word format. For each bit array required by the Level 2 routines, a call is made to UNBIT which unpacks 32 bits starting at a specified bit location. For each byte array required, a call to UPBYT is made to unpack all data associated with the current 32 controllers.

2.6.8.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine UPBL2

2.6.9 SUBROUTINE UPKMC

2.6.9.1 Purpose

The purpose of UPKMC is to unpack the leftmost 17 bits of KMCSP.

2.6.9.2 Relationship

This routine is called by:

```
CALL UPKMC
```

The subroutine is called every one second by Routine N.

2.6.9.3 Assumption

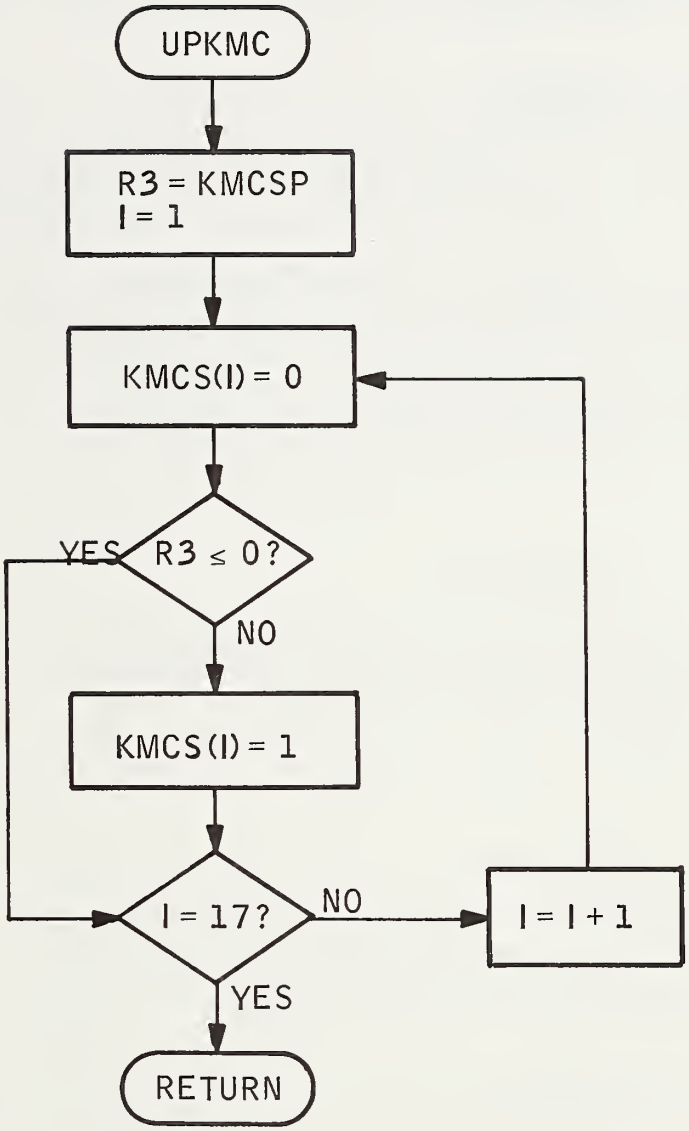
None.

2.6.9.4 Approach

Each bit of KMCSP is examined. If the bit is a "1", KMCS(I) is set to one. Otherwise it is set to zero.

2.6.9.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine UPKMC

2.6.10 ROUTINE B

2.6.10.1 Purpose

Routine B examines the vehicle detector arrays for an indication of vehicle presence. From this indication, the routine records the start time and duration (presence) of each vehicle passage. Whenever an end of vehicle is sensed, the Once per Vehicle Routine, Routine C, is performed. Changes in detector states are ignored if the state does not remain stable for at least 2 sampling times (1/16 of a second).

2.6.10.2 Relationship

This routine is entered every 1/32 of a second from Routine A and returns to that routine.

2.6.10.3 Assumption

Routine A will schedule Routine B at a frequency fast enough to allow accurate computation of occupancy.

2.6.10.4 Approach

This routine is entered every 1/32 of a second from the Executive Routine, Routine A. All detector data is stored by the Executive Routine in an array of packed words, one bit per detector. This routine will unpack the detector words and identify those detectors that have changed state since the last pass through this routine. Those detectors that have had a change of state are checked to determine whether the change indicates the beginning of a vehicle or the end of one. To reduce the effect of spurious pulses,

logic is used to indicate a "change of state" only when the output presence indications have maintained the same state for at least two scan periods.

Each time an end of vehicle is identified, the routine computes the total time that the vehicle spent in the particular detectors field of sensitivity; that is, the presence in seconds.

When an end of vehicle pulse is processed, this routine enters the Once per Vehicle Routine, Routine C. After Routine C is completed, control is returned to this routine and the next detector indicating a change in state is processed. After all detectors have been examined, and all those needing processing have been processed, control is returned to the Executive Routine.

The technique used in Routine B is a word oriented quadruple buffer scheme. Three buffers are required to determine if changes in detector states remain stable for 2 sampling times. The fourth buffer allows new data to be input from the MUX while the other three buffers are being processed.

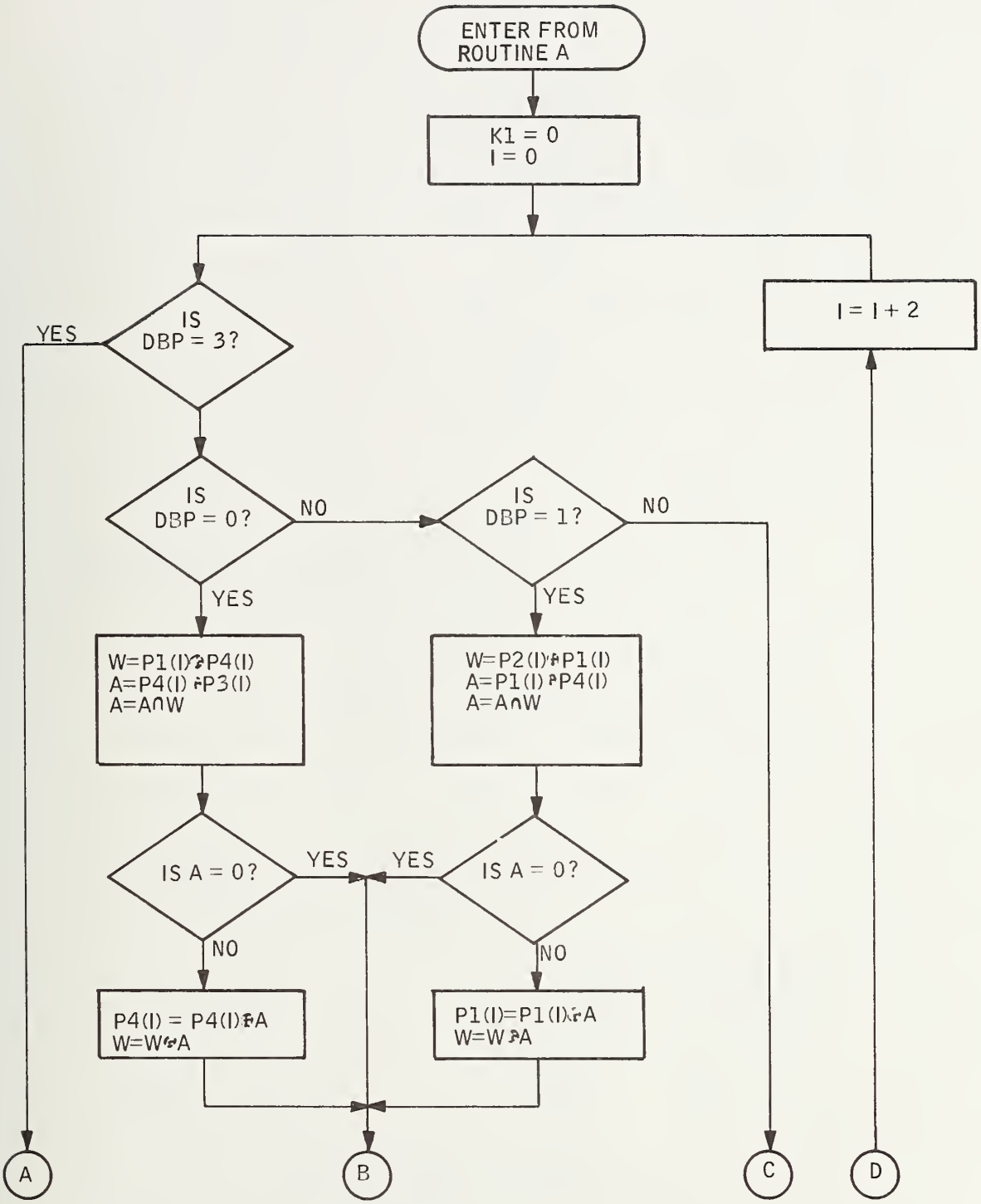
Upon entry, the routine initializes counters and examines the Detector Buffer Pointer (DBP) to determine which three buffers are to be processed. The first step is to determine if two changes of state have occurred in the past 2 samples for a particular bit (detector) in the Ith word. If two changes of state have occurred (indicating a spike or a gap), the change in this particular bit is ignored by complementing the respective bit in the previous (middle) data word and W. W is the exclusive OR (denoted by the symbol $\oplus$) of the previous data word and data word two samples ago, and indicates bit positions in which the previous changes of state lie.

Regardless of whether two changes of state have occurred or not, W is tested to determine if at least one bit has changed state. If there is at least one bit with a change, indicated by a logical "one", each of the 4 bytes

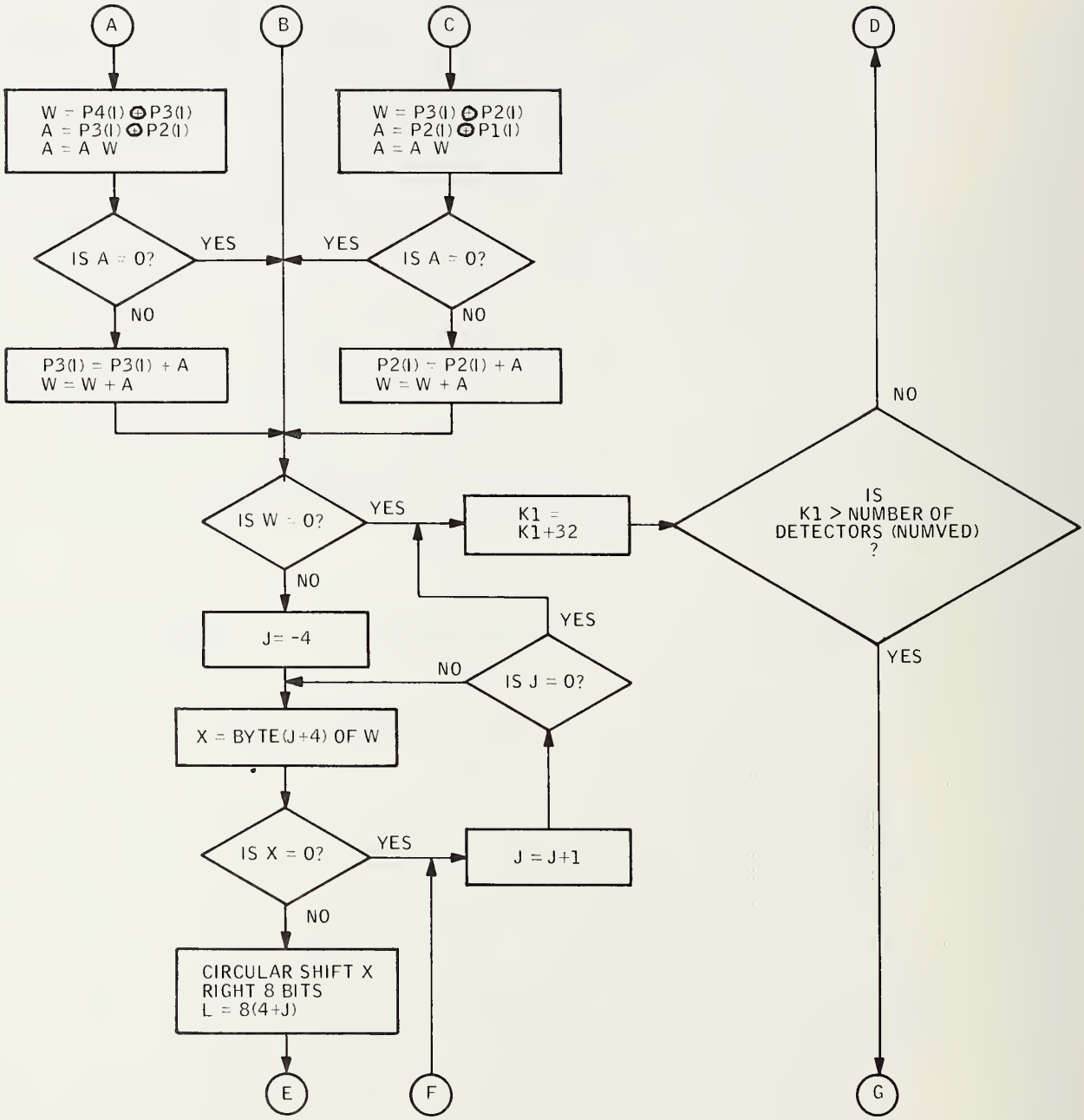
that comprise W are examined to see if they contain any "ones". If a particular byte X is not zero, the detectors corresponding to the nonzero bits of X are isolated. If TSTART(K) is positive, the change in state of the Kth detector represents the beginning of a vehicle presence and the present real time is stored in TSTART(K) with a negative sign. If TSTART(K) is negative, the change in state of the Kth detector represents an end of vehicle presence, hence the pulse duration TT is computed, the present real time is stored in TSTART(K) with a positive sign, and the Once per Vehicle Routine, Routine C, is performed. After all the detectors with changed states in byte X have been processed, the remaining bytes in W are examined. After all 4 bytes in W have been examined and processed, when required, the next word from the three vehicle detector buffers is analyzed. When the entire buffer has been analyzed, the routine is exited.

2.6.10.6 Listing

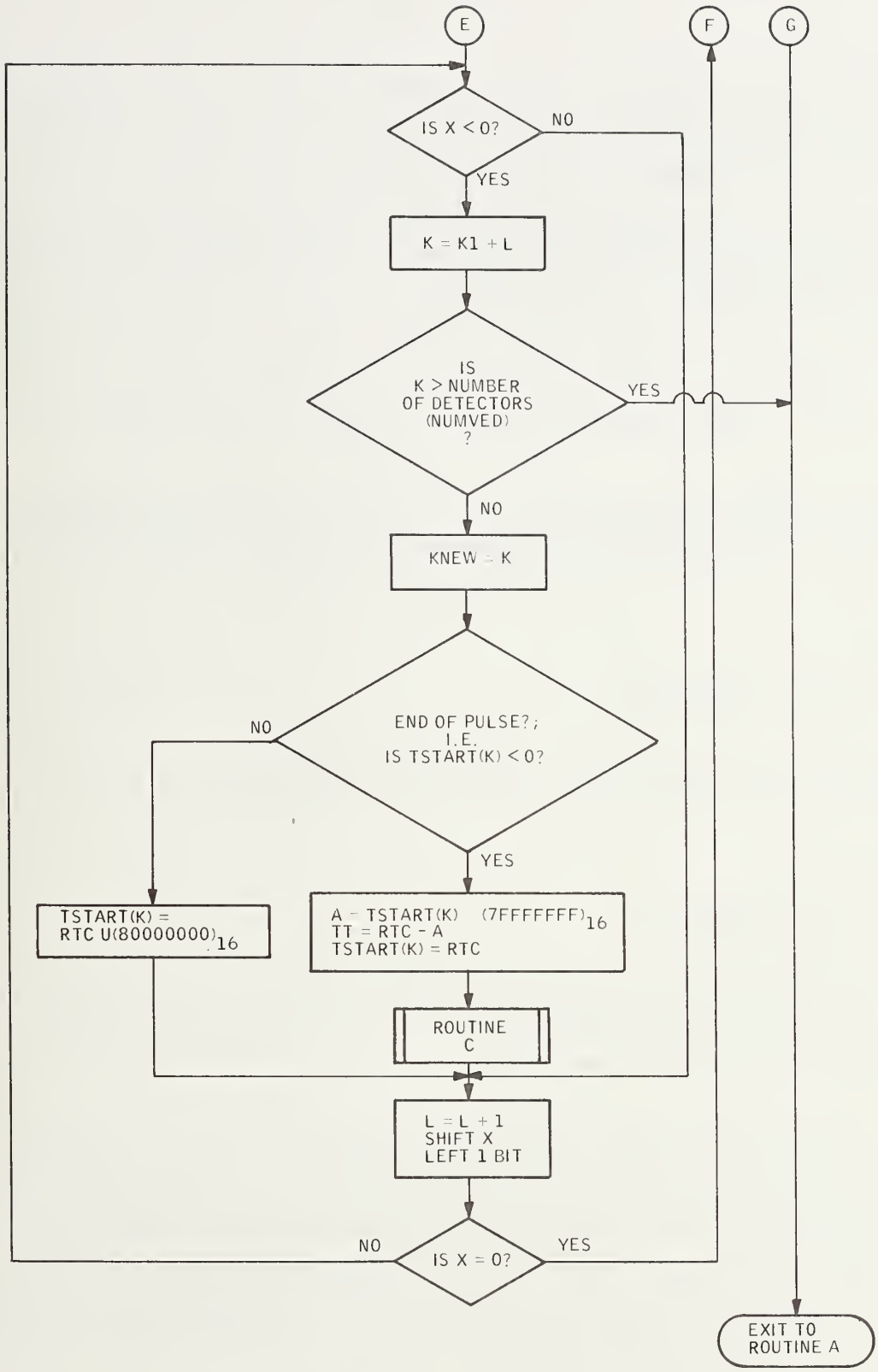
See Volume III, 2GCF Routine Listings.


ENTER FROM ROUTINE A
K1 = 0
I = 0
I = I + 2
IS DBP = 3?
YES
IS DBP = 0?
NO
IS DBP = 1?
NO
YES
YES
W=P1(I)∨P4(I)
A=P4(I)∧P3(I)
A=A∩W
W=P2(I)∧P1(I)
A=P1(I)∧P4(I)
A=A∩W
IS A = 0?
YES
YES
IS A = 0?
NO
NO
P4(I) = P4(I)∧A
W=W∨A
P1(I)=P1(I)∨A
W=W∧A
A
B
C
D

Routine B



Routine B (Continued)



Routine B (Concluded)

2.6.11 ROUTINE C

2.6.11.1 Purpose

Routine C accumulates raw car counts, raw occupancy and raw speed, corrected for bias, for each detector.

2.6.11.2 Relationship

This routine is asynchronous. It is entered once per vehicle per detection, i.e., each time a detector senses the end of a vehicle. This routine is called by Routine B and returns to that routine.

2.6.11.3 Assumption

Error checking for failed detectors is performed by Routine E.

2.6.11.4 Approach

The technique used in Routine C is detector oriented. Whenever an end of vehicle is sensed in Routine B, Routine C is entered, and upon completion, control is returned to Routine B.

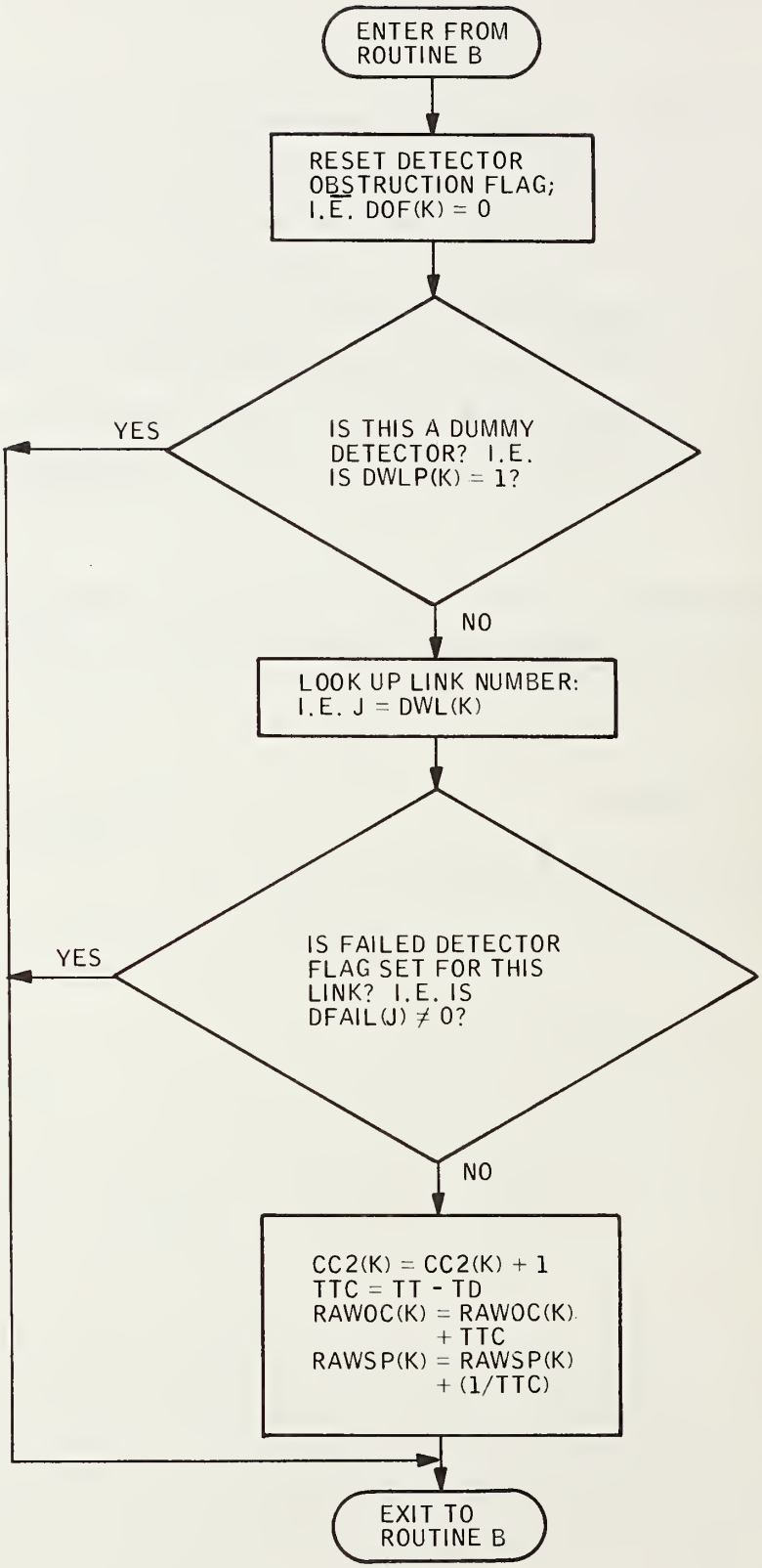
After the Detector Obstruction Flag, DOF(K), has been reset, the link number J corresponding to detector number K is determined. If there is a defective detector on this link, the routine is exited. Otherwise, the corrected pulse length (TTC), the raw occupancy (RAWOC), and raw speed (RAWSP), are computed for this detector. If detector K is the only detector on link J, the routine is exited.

Three additional arrays for each detector have been added to the data base in the second generation software system to accumulate raw data for the second generation surveillance Routines (RTN5 and RTNFT). Routine C loads the raw count accumulator (CC2P), the raw speed accumulator (RAWSPP), and the raw occupancy accumulator (RAWOCPP) once per vehicle. Routines RTN5 and RTNFT process this data every 5MINCT seconds to obtain average link volume, average link speed, average link occupancy, free flow link volume, free flow link speed, and free flow link occupancy. After each accumulator is processed by RTN5, it is reset to zero.

Upon completing the processing of the present detector the routine exits to the Detector Input Data Interpretation Routine, Routine B.

2.6.11.5 Listing

See Volume III, 2GCF Routine Listings.


ENTER FROM ROUTINE B
RESET DETECTOR OBSTRUCTION FLAG; I.E. DOF(K) = 0
IS THIS A DUMMY DETECTOR? I.E. IS DWLP(K) = 1?
YES
NO
LOOK UP LINK NUMBER: I.E. J = DWL(K)
IS FAILED DETECTOR FLAG SET FOR THIS LINK? I.E. IS DFAIL(J) ≠ 0?
YES
NO
CC2(K) = CC2(K) + 1
TTC = TT - TD
RAWOC(K) = RAWOC(K) + TTC
RAWSP(K) = RAWSP(K) + (1/TTC)
EXIT TO ROUTINE B

Routine C

2.6.12 ROUTINE E

2.6.12.1 Purpose

This routine identifies detector failures and informs the operator as to the location and type (detector electronics, detector obstruction or communications). It sets flags to prevent use of information emanating from these locations, and updates raw link count, raw link occupancy and raw link speed.

2.6.12.2 Relationship

This routine is entered once per cycle for each group of controllers having the same cycle length. It is called by the Executive Routine in Level 3 and exits to that routine. It calls the CRT Failure Table Update Subroutine of Routine K and also calls Routine F.

2.6.12.3 Assumption

None.

2.6.12.4 Approach

This routine first identifies, from the Kth cycle start flag, which set of detectors (grouped by link for each controller) is to be checked. Detector numbers are indexed and if one belongs to the set under consideration, failure status for each detector is determined in the following manner.

If present pulse duration, IPLS, exceeds a specified interval, TT7, detector failure is indicated and the failed detector flag is set. If TT3<IPLS<TT7, "possible detector obstruction" flag is set, where TT3 is related to the maximum cycle length encountered in the system.

If a present gap duration, GAP, exceeds some multiple, M, of normal gap length, Tn, and is also greater than a specified interval, 180 secs, i.e.:

$$GAP > MTn$$

and

$$GAP > 180 \text{ secs},$$

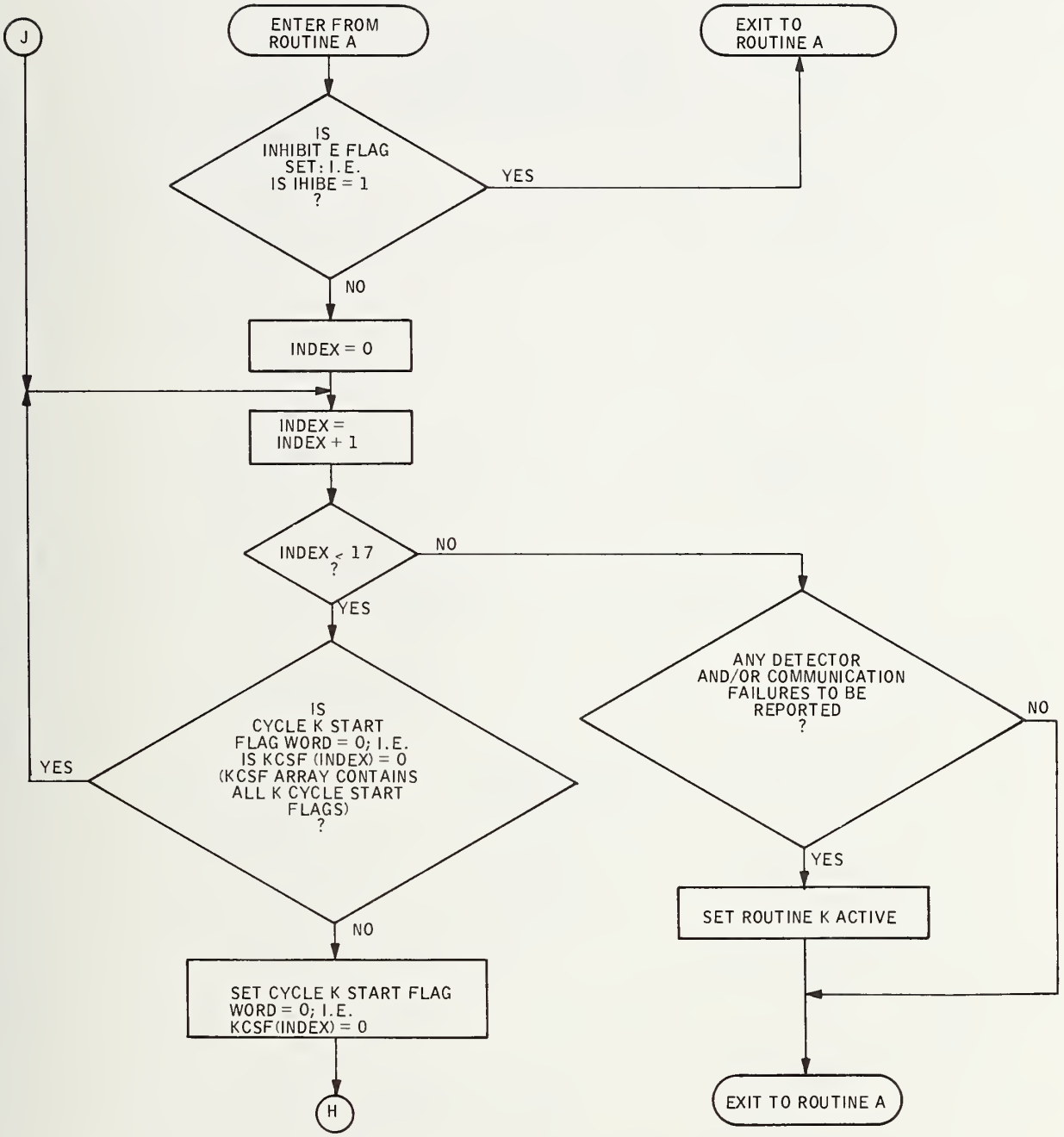
and if the "possible detector obstruction" flag has been set, detector obstruction is identified. The "detector obstruction" flag is then set.

If the "possible detector obstruction" flag is not set and inequality (1) holds, the operator is notified that communication failure and the "communication failure" flag is set. The detector is also reported as failed if the count is greater than a threshold, Nc.

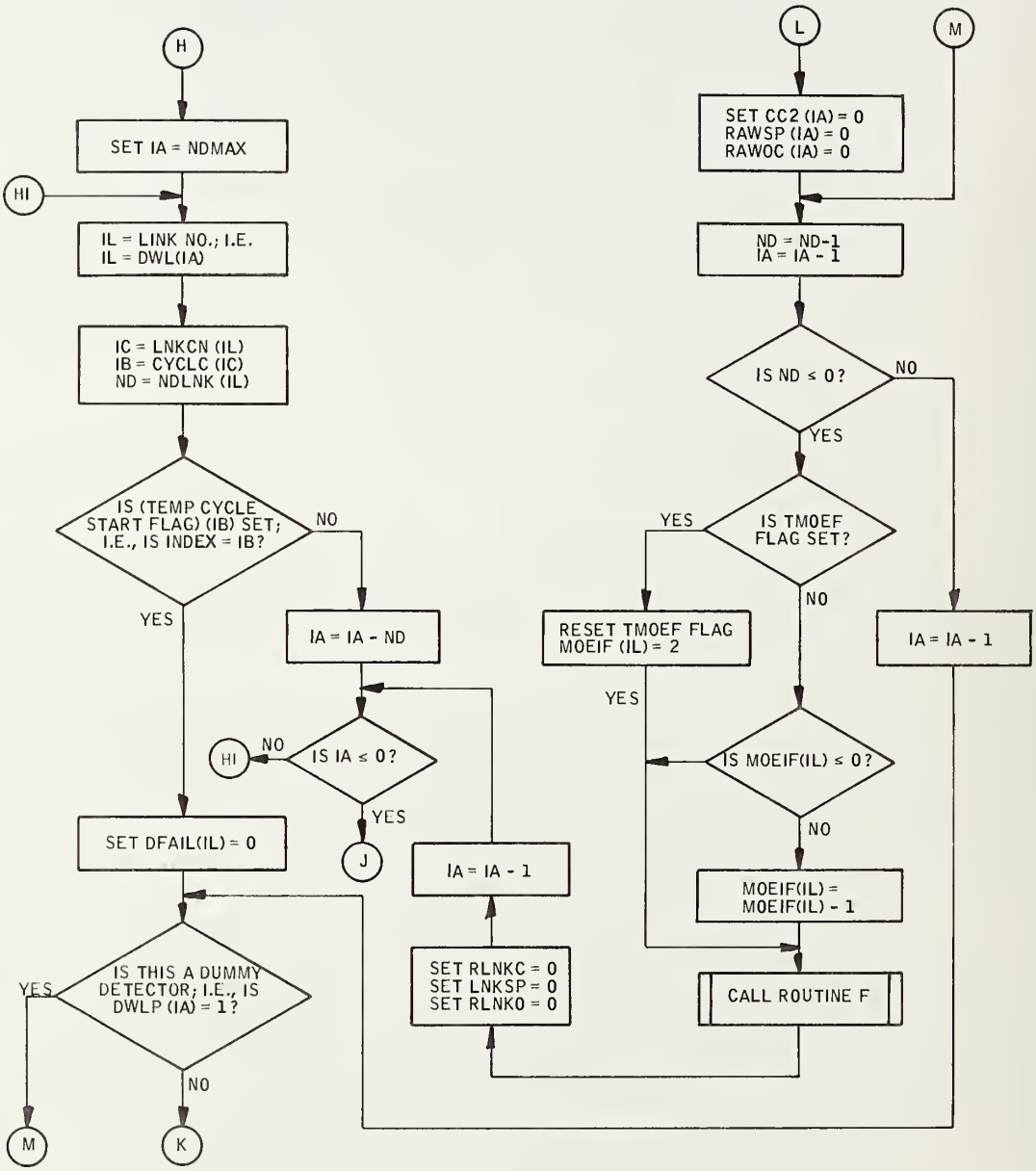
If no failure is identified, the detector raw car count is added to the corresponding link count and the detector raw occupancy count is added to the corresponding raw link occupancy count. If any failure on a link is detected, a MOE Inactive Flag and a Failed Detector Flag are set. If the corresponding controller is in standby, the MOE Inactive Flag is also set.

2.6.12.5 Listing

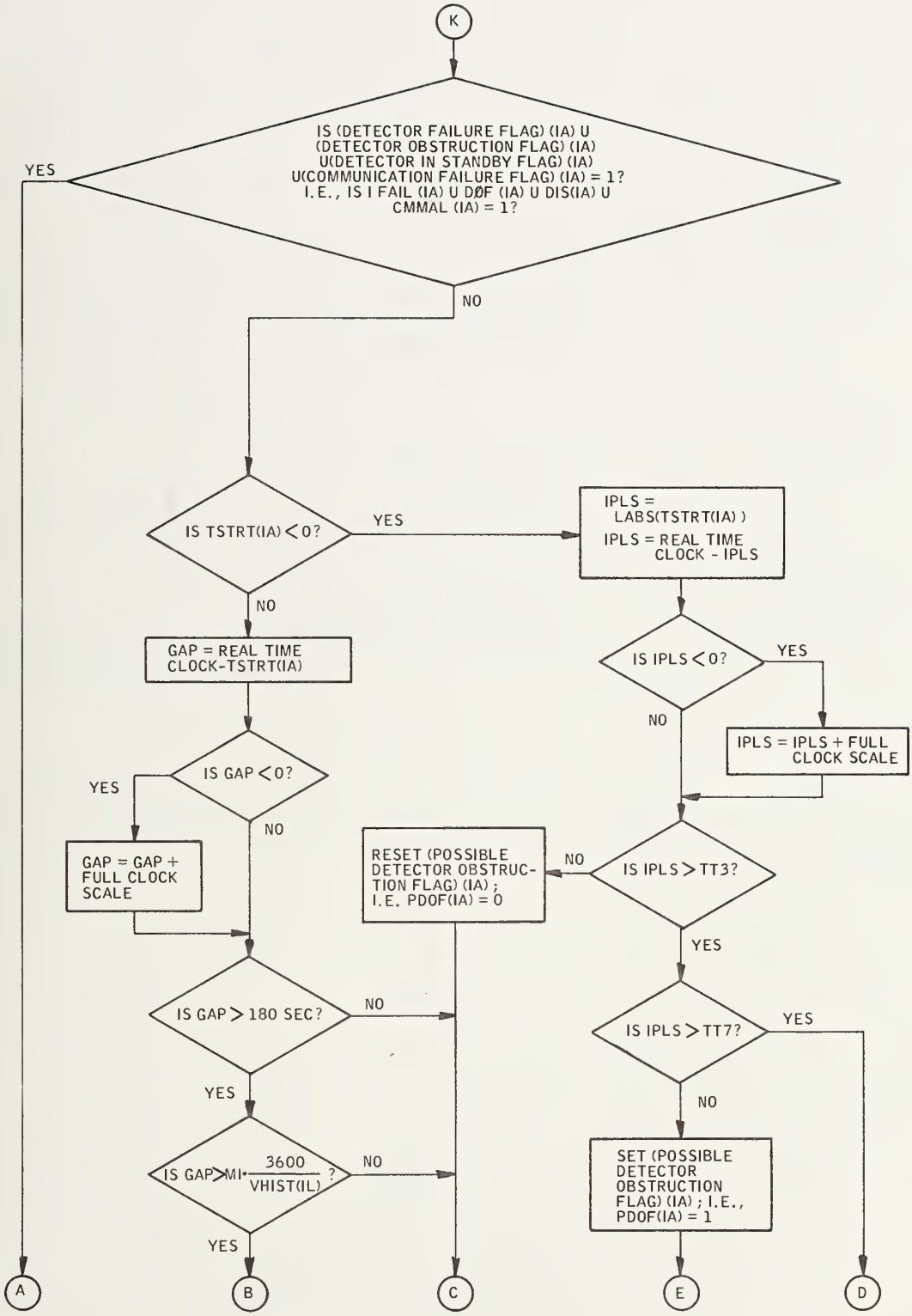
See Volume III, 2GCF Routine Listings.


J
ENTER FROM ROUTINE A
EXIT TO ROUTINE A
IS INHIBIT E FLAG SET: I.E. IS IHIBE = 1 ?
YES
NO
INDEX = 0
INDEX = INDEX + 1
INDEX < 17 ?
NO
YES
IS CYCLE K START FLAG WORD = 0; I.E. IS KCSF (INDEX) = 0 (KCSF ARRAY CONTAINS ALL K CYCLE START FLAGS) ?
YES
NO
SET CYCLE K START FLAG WORD = 0; I.E. KCSF(INDEX) = 0
H
ANY DETECTOR AND/OR COMMUNICATION FAILURES TO BE REPORTED ?
NO
YES
SET ROUTINE K ACTIVE
EXIT TO ROUTINE A

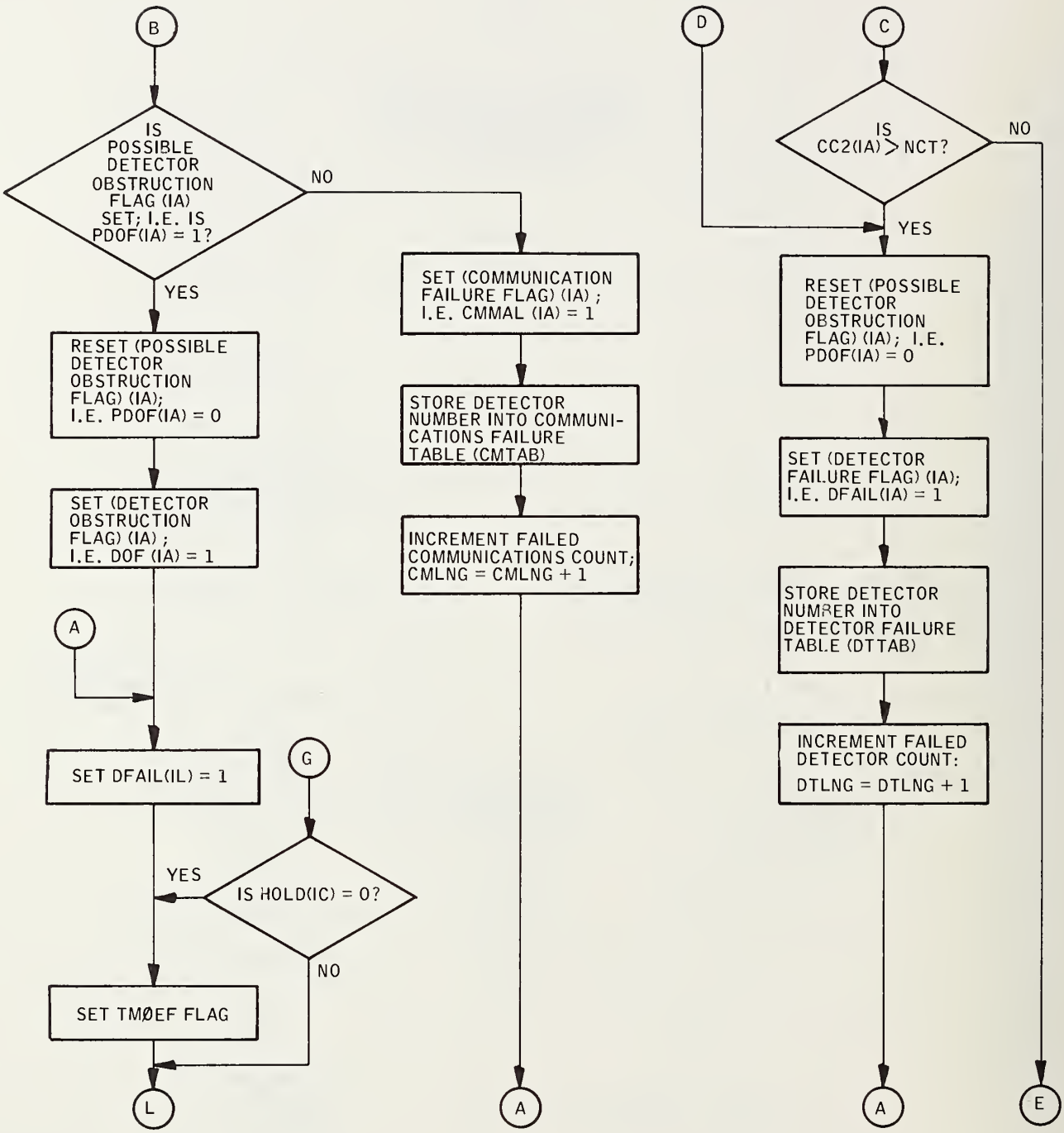
Routine E



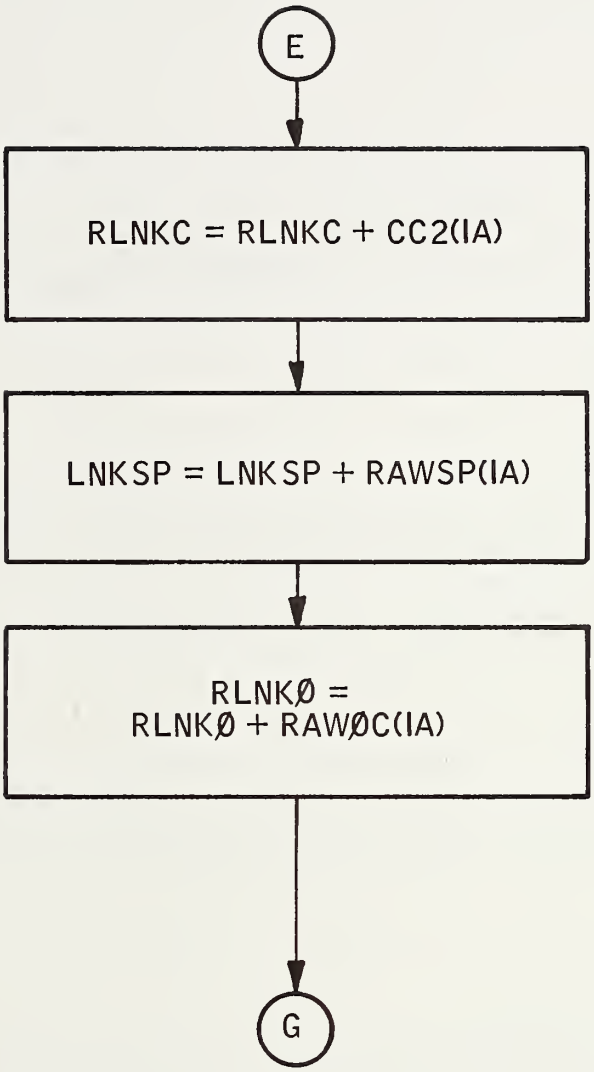
Routine E (Continued)



Routine E (Continued)


B
IS POSSIBLE DETECTOR OBSTRUCTION FLAG (IA) SET; I.E. IS PDOF(IA) = 1?
NO
YES
RESET (POSSIBLE DETECTOR OBSTRUCTION FLAG) (IA); I.E. PDOF(IA) = 0
SET (DETECTOR OBSTRUCTION FLAG) (IA); I.E. DOF (IA) = 1
A
SET DFAIL(IL) = 1
G
YES
IS HOLD(IC) = 0?
NO
SET TMØEF FLAG
L
SET (COMMUNICATION FAILURE FLAG) (IA); I.E. CMMAL (IA) = 1
STORE DETECTOR NUMBER INTO COMMUNICATIONS FAILURE TABLE (CMTAB)
INCREMENT FAILED COMMUNICATIONS COUNT; CMLNG = CMLNG + 1
A
D
C
IS CC2(IA) > NCT?
NO
YES
RESET (POSSIBLE DETECTOR OBSTRUCTION FLAG) (IA); I.E. PDOF(IA) = 0
SET (DETECTOR FAILURE FLAG) (IA); I.E. DFAIL(IA) = 1
STORE DETECTOR NUMBER INTO DETECTOR FAILURE TABLE (DTTAB)
INCREMENT FAILED DETECTOR COUNT: DTLNG = DTLNG + 1
A
E

Routine E (Continued)



Routine E (Concluded)

2.6.13 ROUTINE F (LINK VOLUME, OCCUPANCY AND SPEED EVALUATION)

2.6.13.1 Purpose

Routine F accumulates link car count, link occupancy and link speed. It also computes volume, occupancy and average speed, by link, and smoothes these values with past data. If a link is inactive due to failures, stored typical volume and occupancy values are used for display.

2.6.13.2 Relationship

This routine is entered once per cycle for each link. It is called by Routine E and returns to that routine.

2.6.13.3 Assumption

Error checking for failed detectors is performed by Routine E.

2.6.13.4 Approach

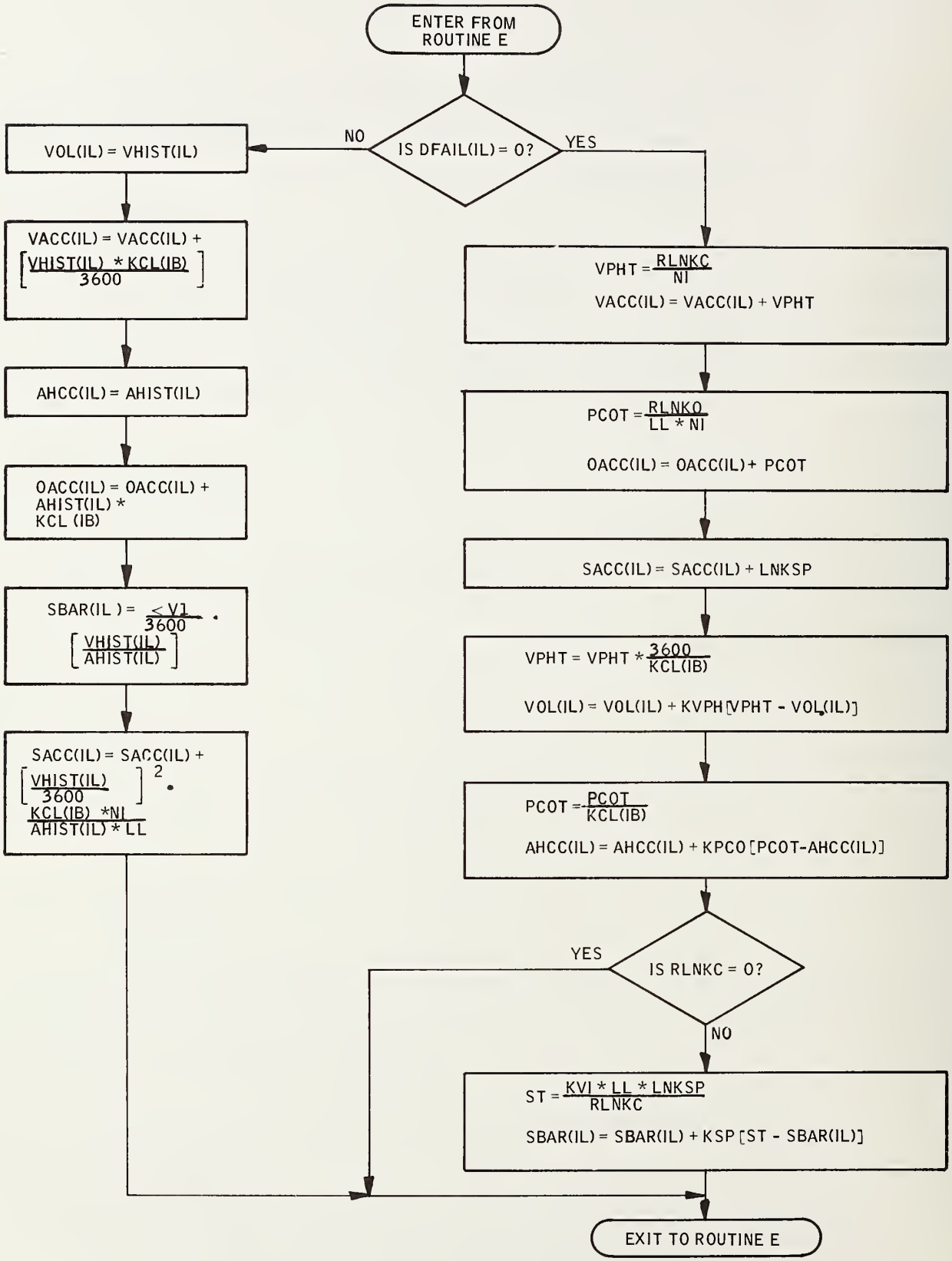
For the link being processed, the routine first determines the number of detectors on the link and the cycle length of its controller. If the link is active, the following computations are made:

- Raw link count, raw link occupancy and link speed are accumulated.
- Volume in vehicles/hour, occupancy in percent and average speed in miles/hour are computed and smoothed.

If the detector on a link is not active (failed), stored history values of volume and occupancy are accumulated.

2.6.13.5

See Volume III, 2GCF Routine Listings.


ENTER FROM ROUTINE E
IS DFAIL(IL) = 0?
NO
YES
VOL(IL) = VHIST(IL)
VACC(IL) = VACC(IL) + [VHIST(IL) * KCL(IB) / 3600]
AHCC(IL) = AHIST(IL)
OACC(IL) = OACC(IL) + AHIST(IL) * KCL (IB)
SBAR(IL) = < V1 / 3600 . [VHIST(IL) / AHIST(IL)]
SACC(IL) = SACC(IL) + [VHIST(IL) / 3600]^2 . KCL(IB) *NI / AHIST(IL) * LL
VPHT = RLNKC / NI
VACC(IL) = VACC(IL) + VPHT
PCOT = RLNKO / LL * NI
OACC(IL) = OACC(IL)+ PCOT
SACC(IL) = SACC(IL) + LNKSP
VPHT = VPHT * 3600 / KCL(IB)
VOL(IL) = VOL(IL) + KVPH [VPHT - VOL(IL)]
PCOT = PCOT / KCL(IB)
AHCC(IL) = AHCC(IL) + KPCO [PCOT-AHCC(IL)]
IS RLNKC = 0?
YES
NO
ST = KVI * LL * LNKSP / RLNKC
SBAR(IL) = SBAR(IL) + KSP [ST - SBAR(IL)]
EXIT TO ROUTINE E

Routine F

2.6.14 ROUTINE H (15-MINUTE PERFORMANCE AND STATUS REPORT)

2.6.14.1 Purpose

Routine H provides 15-minute performance and status reports on the line printer for the UTCS system. These reports contain: the intersection status (Figure 3); a log of all operator entered control panel system requests made during the last 15 minutes (Figure 4); the number of failures in the system; controller and detector status (Figure 5); system status by section (Figure 6); and UTCS system performance by link (Figure 7). In addition, it records on magnetic tape all the Measures of Effectiveness (MOEs) at 15-minute intervals.

If the Change Formatting Subroutine (HFMT), which logs operator control panel requests, finds the log table filled it sets Routine H active in order to force a print out of the log table.

2.6.14.2 Relationship

The Change Formatting Subroutine (HFMT) is scheduled asynchronously from Routine M. This routine is scheduled at Level 3 when required by Routine M. This routine is divided into the following subroutines in the FORTRAN software which are called by Routine H: CAL15, CALRL, TSTAP, OUTAP, PRNTF, TSTLP, TIMEH, DECON, MHEAD, STAT, STMSG, and LKDAT.

2.6.14.3 Assumption

This routine is entered every 15 minutes on the 15-minute mark and when shutdown is requested.

UTCS INTERSECTION OFFSETS MAR 25 76 1930

INTERSECTION NUMBER	A PHASE OFFSET	B PHASE OFFSET	C PHASE OFFSET	CYCLE LENGTH	SUBNETWORK NUMBER	CORE GROUP NUMBER
1	28	8	0	80	2	3
2	17	70	0	80	2	2
3	15	75	0	80	2	2
4	47	28	0	80	1	1
5	20	3	0	55	1	1
6	58	27	0	80	2	2
7	12	50	0	55	1	1
9	44	12	41	55	1	1
10	51	17	37	55	1	1
11	13	54	1	55	1	1
12	15	76	0	80	2	2
13	18	58	0	80	2	3
14	0	60	0	80	2	3
15	2	52	42	80	2	3
16	1	59	1	80	2	3
17	60	76	19	80	2	3
18	45	15	0	80	2	3
19	34	2	0	80	2	3
20	75	49	0	80	2	3
21	14	66	0	80	2	3
22	11	64	0	80	2	2
23	14	38	56	80	2	3
24	42	6	53	80	4	5
25	76	42	0	80	4	4
26	47	25	0	80	4	5
27	35	63	0	80	4	5
28	51	24	0	80	3	0
29	15	74	15	80	3	0
30	46	8	0	80	3	0
31	6	27	17	75	4	6
32	0	28	0	75	4	6
33	58	7	17	75	4	6
34	56	12	0	80	3	0
35	44	14	0	80	3	0
36	38	60	0	80	3	0
37	79	38	44	80	3	0
38	42	64	79	80	3	0
39	57	34	57	75	4	6
40	56	20	0	75	4	6
41	57	13	0	75	4	6
42	56	10	57	75	4	6
43	76	46	0	80	3	0
44	6	55	0	80	3	0
45	56	20	0	80	3	0
46	44	6	0	80	3	0
47	46	40	0	80	3	0
48	76	39	0	80	3	0
49	39	78	0	80	3	0
50	57	21	0	75	4	6
51	5	58	0	75	4	6
52	4	51	0	75	4	6
53	4	57	4	75	4	6
54	43	15	42	80	4	5
55	41	72	0	80	4	5
56	63	26	0	80	4	5
57	43	16	0	40	3	0
58	6	59	0	75	4	6
59	41	23	0	80	4	4
60	45	79	0	80	4	4
61	45	73	0	80	4	4
62	13	73	0	80	4	5
63	46	33	0	80	4	5
64	0	47	0	80	4	5
65	77	23	48	80	4	5
66	46	19	45	80	4	5
67	73	33	0	80	4	5
68	74	41	0	80	4	5
69	49	17	0	80	4	5
70	45	13	0	80	4	5
71	43	12	0	80	4	5
72	38	9	0	80	4	4
73	40	23	0	80	4	4
74	23	62	0	80	4	4
75	7	29	43	80	4	4
76	51	27	0	80	4	4
77	19	41	0	80	4	4
81	79	40	0	80	4	4
82	0	45	0	80	4	4
83	16	61	0	80	4	4
84	58	23	0	80	4	4
85	48	29	0	80	4	4
86	76	34	0	80	4	4
87	37	70	0	80	4	4
88	40	5	5	80	4	4
89	42	69	0	80	4	4
90	15	51	0	80	4	5
91	19	40	70	80	4	5
92	10	10	0	40	3	0

Figure 3. Intersection Status Report

UTCS INTERSECTION OFFSETS MAR 25 76 1931 3

INTERSECTION NUMBER	A PHASE OFFSET	B PHASE OFFSET	C PHASE OFFSET	CYCLE LENGTH	SUBNETWORK NUMBER	CORE GROUP NUMBER
93	26	48	44	80	3	5
94	3	67	0	80	3	5
95	14	14	0	40	0	0
96	19	67	0	80	3	4
97	34	74	0	80	3	4
98	36	70	0	80	3	4
99	71	79	16	80	3	4
100	47	75	0	80	3	4
103	69	45	0	80	2	2
104	42	35	0	80	2	2
105	69	35	0	80	2	2
106	69	27	47	80	2	2
109	60	28	0	80	0	0
110	76	36	56	80	0	0
111	9	29	0	40	0	0
112	74	46	0	80	0	0
113	42	78	0	80	0	0
114	25	77	0	80	0	0
115	24	7	0	40	0	0
116	7	29	0	40	0	0
117	6	26	0	40	0	0
118	17	38	0	40	0	0
119	31	12	0	40	0	0
120	19	49	0	55	1	1
121	58	23	58	80	2	2
122	55	27	0	80	2	2
123	69	41	0	80	2	2

Figure 3. Intersection Status Report (Concluded)

UTCS 15 MINUTE STATUS AND PERFORMANCE REPORT

DATE MAR 25 76 TIME 1931

CHANGES SINCE LAST REPORT

TIME	TYPE	NUMBER	CHANGE
1920	SYS	2	ANLN
1920	SYS	0	IBD
1920	SYS	3	TRSP
1928	CONT	68	BACK
1925	CONT	68	REPR
1928	CONT	68	ANLN

Figure 4. Log of Control Panel System Requests Made during Last 15 Minutes

*** UTCS CONTROLLER STATUS ***

48 505 1136

Figure 5. Controller Status Report

HISTORY OFF *** UTCS SYSTEM STATUS ***

SECTION	TIME	DESIRED MODE	ACTUAL MODE	PATTERN NO.	CIC IN OVER	FAILURES DET	FAILURES CONT
1	1920	TRSP	TRSP	1	0	0	0
2	1920	TRSP	TRSP	1	0	0	0
3	1920	TRSP	TRSP	1	0	0	0
4	1920	TRSP	TRSP	1	0	0	0

Figure 6. System Status Report by Section

UTCS SYSTEM PERFORMANCE REPORT

CURRENT CUMULATIVE MOE

OUT OF TOLERANCE LINK NUMBER	HISTORY VOL (VEH)	HISTORY OCC (PCT)	VOL (VPH)	OCC (PCT)	AV.SP. (MPH)	TRAV.TIME (SEC/VEH)
1	477	7	412	20	12	14.6
2	636	21	288	4	25	9.4
3	333	21	276	25	11	20.4
4	288	4	264	4	22	9.3
5	193	16	188	2	28	5.1
6	173	7	0	0	0	.0
7	351	15	280	4	24	9.3
8	201	18	208	4	16	9.1
9*	200	4	0	0	0	.0
10	391	24	348	15	12	20.8
11	342	17	276	9	13	19.3
12	411	8	316	9	17	17.3
13	382	7	0	0	0	.0
15	479	9	304	5	23	7.2
16	259	9	184	9	16	19.6
17	139	3	100	1	24	1.5
18	287	4	120	2	25	6.5
19	355	5	384	4	28	11.1
20	275	8	316	4	29	8.6
21	354	5	0	0	0	.0
22*	145	2	0	0	0	.0
23	94	2	24	0	30	10.3
24	425	11	360	7	20	14.2
25	436	14	0	0	0	.0
26	101	4	112	2	18	8.1
27	385	17	312	13	25	9.0
28	85	4	128	2	23	6.3
29	49	5	0	0	0	.0
30	304	8	0	0	0	.0
31	89	5	56	1	26	5.6
32	255	4	316	3	31	7.3
33	242	6	148	2	23	6.2
34	258	3	212	2	32	7.2
35	169	15	124	15	15	9.8
36	450	10	176	2	24	5.9
37	96	9	52	1	20	7.1
38	462	10	372	6	21	6.7
39	98	5	136	4	22	6.4
40	519	12	484	6	25	5.7
41	132	9	88	1	24	6.0
42	490	11	360	5	22	6.4
43	206	21	304	4	23	6.3
44	475	4	408	6	24	5.8
45	209	20	196	3	21	6.8
46	374	10	304	4	22	6.4
47	448	11	320	4	23	6.2
48	116	8	48	1	21	6.8
49	426	10	308	3	30	4.8
50	180	4	148	2	25	10.1
51	123	3	100	2	18	3.7
52	274	4	0	0	0	.0
53	272	4	152	2	25	12.0
54	245	16	152	8	17	16.8
55	89	1	0	0	0	.0
56	319	6	284	5	22	10.8
57	137	3	92	0	26	10.4
58	205	6	208	3	24	5.1
59	100	3	100	2	22	1.5
60	107	5	144	8	21	8.1
61	142	6	116	8	17	12.3
62	413	16	216	3	26	9.9
63	342	17	172	5	18	13.1
64	105	3	52	1	19	7.2
65	446	18	180	2	26	8.9
66	271	13	120	1	29	6.1
67	466	23	356	13	25	10.3
68	531	21	324	6	23	10.9
69	413	17	208	3	23	9.7
70	304	5	148	2	25	9.1
71*	500	15	0	0	0	.0
72	384	14	244	3	25	10.1
73	305	17	128	2	27	5.3
74	487	14	380	15	17	11.8
75	354	9	248	3	30	8.1
77	335	8	204	3	20	12.5
78	374	16	248	8	21	4.3
79	250	24	188	3	23	8.8
80	389	13	176	2	27	9.2
81	515	21	220	3	26	7.8
82	453	16	200	3	22	9.5
83	240	13	204	3	22	9.8
85	225	10	148	2	27	7.4
86	244	10	108	2	16	16.8
87	153	4	64	2	15	12.7
88	334	10	220	3	25	5.7
89	430	22	220	4	21	11.8
90	376	22	124	3	22	6.4
91	104	7	128	1	29	10.8
92	435	14	184	4	19	4.1
93	326	21	176	2	28	7.3

Figure 7. UTCS System Performance Report by Link

UTCS SYSTEM PERFORMANCE REPORT

OUT OF TOLERANCE LINK NUMBER	HISTORY VOL (VEH)	HISTORY ACC (PCT)	CURRENT CUMULATIVE MOE VOL (VPH)	ACC (PCT)	AV.SP. (MPH)	TRAV.TIME (SEC/VEH)
94	0	0	144	8	18	8.1
95	252	14	184	9	25	10.1
96	225	15	172	7	22	12.6
98	522	19	300	5	23	10.4
99	344	24	204	9	23	6.3
100	89	5	64	1	18	15.0
102	97	10	92	1	16	17.6
104	418	16	220	2	25	10.4
105	298	13	216	3	23	6.3
106	340	22	272	15	12	21.8
107	466	20	268	7	20	4.9
108	306	4	232	3	30	7.9
109	296	4	164	2	29	8.8
110	416	14	184	10	12	16.8
111	307	10	276	3	26	5.4
112	301	10	0	0	0	.0
113	336	6	136	2	24	8.8
114	329	6	220	3	26	9.9
116	409	5	212	3	24	7.1
117	440	7	308	6	21	14.7
118*	152	2	0	0	0	.0
119	292	4	292	7	19	16.1
120	358	11	252	5	18	11.1
121	157	3	104	2	21	7.4
122	304	7	248	5	19	6.6
123	432	12	196	5	23	9.9
124	298	11	144	2	22	12.1
125	632	17	364	9	16	15.3
126	395	12	36	1	18	11.0
127	455	17	0	0	0	.0
128	383	6	132	3	19	10.7
129	374	20	184	3	21	12.0
130	447	8	244	8	18	16.2
131	196	4	120	2	24	8.9
132	276	26	220	3	22	12.4
133	259	9	144	2	20	15.4
134	509	11	40	1	22	11.3
135	214	9	164	7	14	13.8
136	224	3	0	0	0	.0
137	321	13	228	6	18	13.3
138	211	8	184	3	20	12.6
139	439	7	236	4	20	15.2
140	279	10	112	1	30	6.9
141	228	7	204	4	19	10.8
142	449	13	168	3	21	9.9
143	492	14	216	7	14	16.3
144	97	6	40	1	18	17.5
145	315	17	216	6	20	11.9
146	394	20	204	8	21	10.1
147	547	17	416	9	16	15.3
148	438	24	264	5	17	12.3
149	334	15	244	5	19	10.9
150	311	5	192	3	20	11.0
151	314	17	216	3	21	7.9
152	417	45	48	1	19	10.2
153	347	27	240	8	17	15.1
154	344	14	200	3	21	11.8
155	232	7	132	2	23	9.6
156	358	8	0	0	0	.0
157	226	15	226	10	19	10.6
158	411	16	242	6	21	11.5
159	277	13	156	6	15	12.4
160	385	14	192	3	21	11.8
161	245	13	132	7	15	13.0
162	336	18	124	8	14	5.9
163	233	9	268	5	19	10.5
164	327	13	124	6	14	14.2
165	46	9	52	1	20	11.3
166	273	5	140	2	22	10.8
167	371	9	120	3	20	11.3
168	247	15	148	6	16	12.9
169	341	7	220	11	16	13.4
170	202	10	340	15	23	6.3
171	350	15	176	9	26	6.9
172	330	7	0	0	0	.0
173	133	10	84	1	18	13.6
174	275	20	0	0	0	.0
175	306	17	244	8	14	7.9
176	0	0	92	2	22	8.1
177	334	14	256	7	19	10.8
178	262	20	104	2	14	6.8
179	235	6	124	3	21	11.5
180	424	11	272	5	30	9.4
181	228	5	144	2	21	13.5
182	0	0	20	0	22	11.3
183	299	21	340	8	22	9.6
184	330	21	20	4	14	8.0
185	223	11	64	37	21	11.9
186	224	*	120	1	26	9.4
187	358	15	402	8	21	9.4

Figure 7. UTCS System Performance Report by Link (Continued)

UTCS SYSTEM PERFORMANCE REPORT

CURRENT CUMULATIVE MOE

OUT OF TOLERANCE LINK NUMBER	HISTORY VOL (VEH)	HISTORY OCC (PCT)	VOL (VPH)	OCC (PCT)	AV.SP. (MPH)	TRAV.TIME (SEC/VEH)
188	245	10	128	10	17	13.0
189	203	8	148	14	14	16.7
190	258	9	232	18	13	15.6
191	322	12	148	8	22	10.3
192	317	17	0	0	0	.0
193	403	9	224	12	15	9.1
194	299	14	220	6	19	11.8
195	182	14	120	8	23	6.1
196	49	1	244	8	17	10.8
197	271	10	148	8	31	7.9
198	214	8	144	8	27	8.8
199	271	15	240	8	35	7.1
200	143	8	144	8	26	4.5
201	174	12	132	8	30	8.4
202	279	4	148	8	22	7.3
203	158	6	52	0	26	5.6
204	204	8	68	1	29	10.0
205	271	8	0	0	0	.0
206	272	8	156	8	29	10.6
207	177	8	140	1	30	8.0
208	246	8	144	1	37	3.8
209	96	8	98	1	25	9.3
210	276	8	0	0	0	.0
211	406	8	198	8	21	14.4
212	218	8	144	8	27	9.8
213	472	8	240	8	32	8.6
214	300	6	136	1	29	8.7
215	299	8	144	8	26	10.0
216	241	18	220	7	17	14.8
217	374	6	148	8	27	9.3
218	358	16	244	8	28	8.8
219	246	8	200	8	24	8.7
220	200	8	96	1	25	8.3
221	189	8	104	8	17	4.4
222	226	7	148	8	17	4.5
223	352	6	208	8	23	11.8
224	314	6	68	1	33	7.5
225	413	7	228	6	21	13.1
226	298	11	0	0	0	.0
227	472	8	192	8	25	12.1
228	254	10	92	8	19	3.9
229	243	6	68	8	16	12.4
230	135	8	56	1	22	8.6
231	169	8	120	1	27	9.9
232	180	8	132	8	24	11.6
233	72	5	28	0	26	7.9
234	333	8	144	8	26	8.1
235	252	8	108	1	25	2.9
236	135	8	52	1	21	12.6
237*	346	8	104	1	27	9.1
238*	217	8	192	8	26	7.8
239*	175	8	204	8	23	6.2
240*	109	8	24	0	23	11.0
241	156	8	120	8	22	6.4
242	470	8	240	8	23	7.5
243	115	4	56	1	19	16.1
244	357	8	204	8	23	8.5
245	429	7	256	8	17	10.1
246	297	8	216	8	26	10.1
247	321	8	0	0	0	.0
248	471	13	244	4	21	6.7
249	153	10	44	1	20	7.2
250	342	8	140	8	21	6.8
251	391	16	304	8	20	7.8
252	359	11	148	8	25	9.6
253	60	10	20	0	18	13.7
254	67	4	28	0	21	13.2
255	356	8	0	0	0	.0

Figure 7. UTCS System Performance Report by Link (Concluded)

2.6.14.4 Approach

Upon entry Routine H checks to see if this is a forced printout (log table filled) and if it is, will set a flag so that Routine H will exit after the page is printed. If it is not a forced printout, a check is made to see if the PRINTOUT SUPPRESS button is engaged on the control panel. If it is engaged Routine H will begin processing link data. If the printout is not to be suppressed, a check is made to see if there is anything in the table. If the table is empty, Routine H begins processing the Failure Status page. If there is something to be printed out, a flag is set so that Routine H will begin processing the Failure Status page after the log has been printed.

Routine H begins by calling subroutine OUT2G to output the Intersection Report (Figure 3). Following this, Routine H begins processing the Failure Status page by checking to see if there are any failures in the failure table (FAILTAB). If there are none, Routine H begins processing the Controller Status page (Figure 5). If there are failures, the equipment type and number, the time and day of the failure, and whether the operator has taken action in response to the failure is printed out. A flag is set so that Routine H will begin processing the Controller Status page after the Failure Status page has been output.

Routine H checks the status of all the controllers in the system. It creates a list, in increasing numerical order, of the controllers that are under critical intersection control, have been selected for critical intersection control but not operating as such (inhibited CIC), are in standby, and those that have failed. It prints out this list, if it is not empty, as the Controller Status page and then proceeds to process the Detector Status page.

The Detector Status page is processed in a way similar to the Controller Status page. A list is created in increasing numerical order, of those detectors that are in stand-by, have communication failures, and those that have failed. It prints out this list, if it is not empty, as the Detector Status page and then proceeds to process the System Status page (Figure 6).

For each section the actual mode (TOD, STBY, etc.) and the time it was imposed, the desired mode, the pattern number, number of CIC intersections in operation, number of failed detectors, and number of failed controllers are determined and printed out as the UTCS System Status page.

Routine H processes link data every 15-minutes regardless of the state of the PRINTOUT SUPPRESS button on the control panel. For each link, percent occupancy (OPC), average speed (AVSP) and travel time (TRTM) are calculated. Accumulated daily volume (VDAY), accumulated daily occupancy (ODAY), and accumulated average daily speed (SDAY) are updated. The arrays used for the 15-minute accumulations of volume (VACC), speed (SACC) and occupancy (OACC) are set to zero. The MOEs are collected for each link and placed into the tape buffer (TBUFF). Any link that had nominal performance during the interval since the last 15-minute report is flagged by setting the sign bit of the link number halfword that is put onto tape. Out of tolerance links are determined by performing two checks: the absolute values of the difference between current accumulated volume plus weighted occupancy and stored (history) volume plus weighted occupancy is computed. If this difference and the percent difference exceed preselected threshold values, the link is considered out of tolerance.

After all the links are processed, Routine W is scheduled and a check is made of the PRINTOUT SUPPRESS button on the control panel. If the printout is not to be suppressed, Routine H prints out the UTCS System Performance Report (Figure 7). For each link that is out of tolerance the following information is printed out:

- link number
- history volume
- history percent occupancy
- current cumulative volume for this 15 minute period
- current cunulative percent occupancy for this 15 minute period

- average speed
- average travel time.

In addition, if the controller associated with the link is not on-line an "*" is printed next to the link number. If there is a failed detector on the link, an "H" is printed next to the link number and all MOEs except volume and occupancy are set to zero on both the printout and the tape.

Finally, a check is made to see if it is midnight. If it is, Routine I is scheduled. A check is made to see if it is shutdown. If it is, Routine I is scheduled. Routine H then exits.

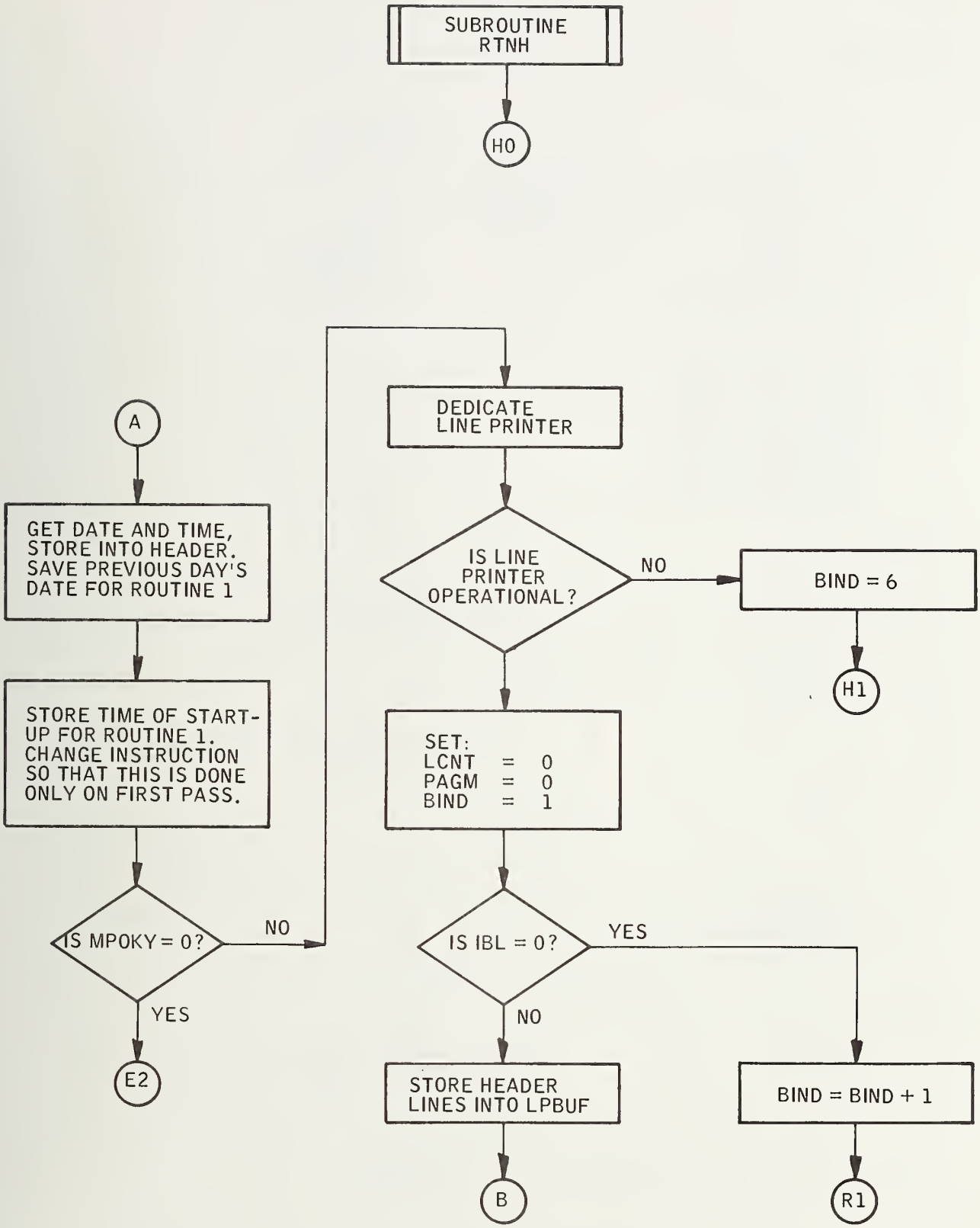
Routine H (Subroutine CTPSRT) has been modified to print the current signal timing plans in effect in the UTCS network. The report contains the controller offsets for A, B, and C-phase as well as the cycle length and subnetwork number. If a controller is not in a section which is in the Traffic Responsive Mode, the subnetwork number is printed as zero.

Because the BPS capability has been deleted from the second generation system, the associated BPS reports have been deleted from Routine H.

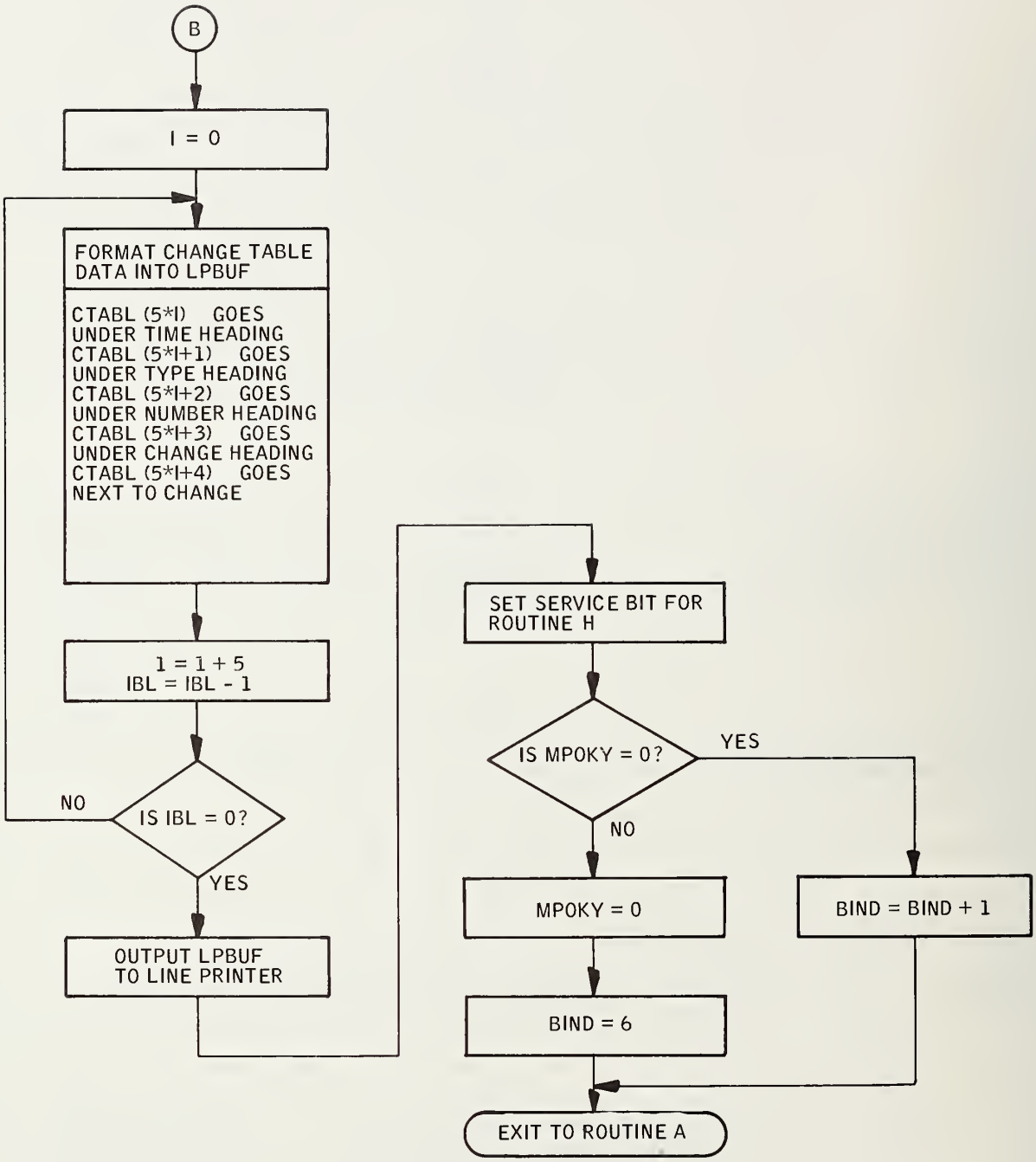
The Change Formatting Subroutine (HFMT) is contained within Routine H. It is called by Routine M to log control panel system requests. For each system request the following information is logged: Time of Change, Type (system, section, controller, detector, detector communications), Number, Change (standby, manual, time-of-day, traffic responsive, history record on, history record off, split, offset, CIC on, CIC off, failure repair, on line, manual extension). In addition, if a manual pattern change was requested, the extension is logged. The change table (CHGTABLE) is designed to hold 44 requests. When this table is filled Routine H is set active in order to print out the table.

2.6.14.5 Listing

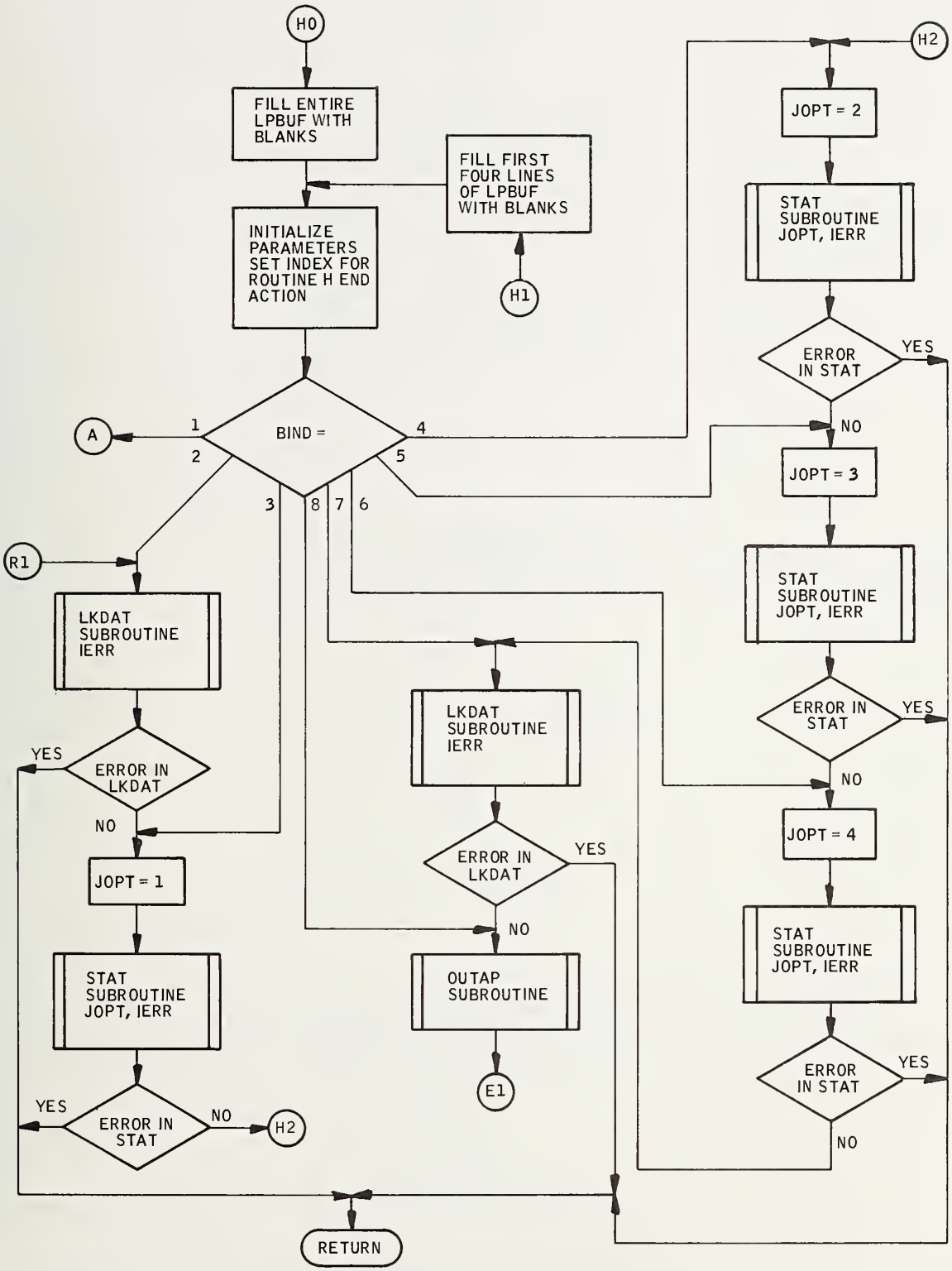
See Volume III, 2GCF Routine Listings.


SUBROUTINE RTNH
H0
A
GET DATE AND TIME, STORE INTO HEADER. SAVE PREVIOUS DAY'S DATE FOR ROUTINE 1
STORE TIME OF START-UP FOR ROUTINE 1. CHANGE INSTRUCTION SO THAT THIS IS DONE ONLY ON FIRST PASS.
IS MPOKY = 0?
NO
YES
E2
DEDICATE LINE PRINTER
IS LINE PRINTER OPERATIONAL?
NO
BIND = 6
H1
SET:
LCNT = 0
PAGM = 0
BIND = 1
IS IBL = 0?
YES
NO
STORE HEADER LINES INTO LPBUF
BIND = BIND + 1
B
R1

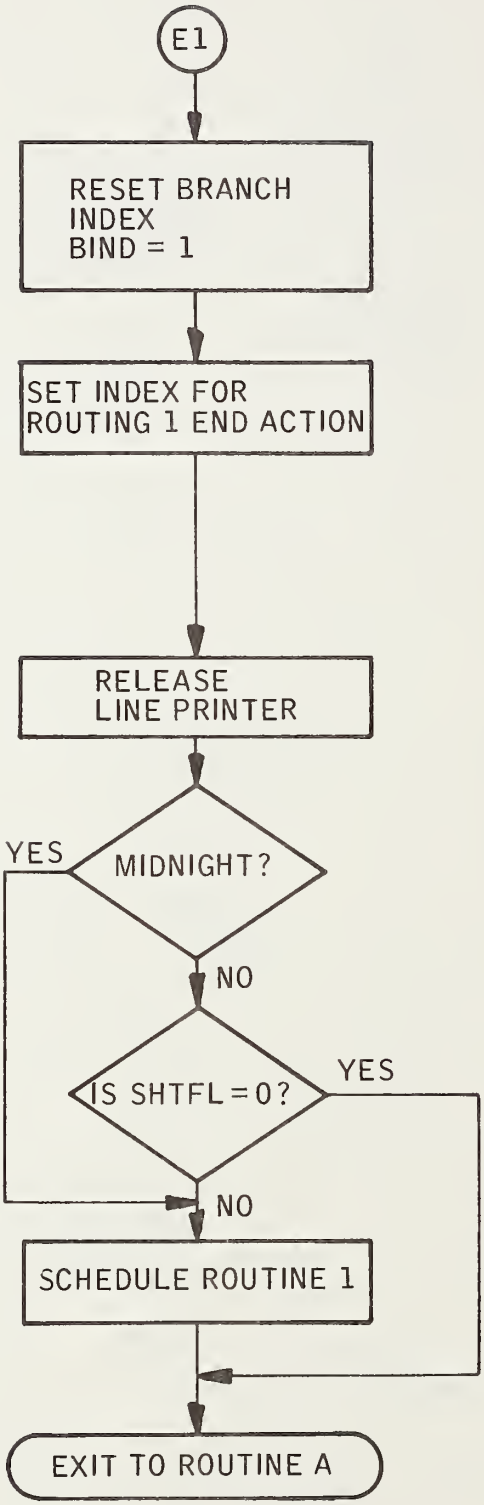
Routine H


B
I = 0
FORMAT CHANGE TABLE DATA INTO LPBUF
CTABL (5*I) GOES UNDER TIME HEADING
CTABL (5*I+1) GOES UNDER TYPE HEADING
CTABL (5*I+2) GOES UNDER NUMBER HEADING
CTABL (5*I+3) GOES UNDER CHANGE HEADING
CTABL (5*I+4) GOES NEXT TO CHANGE
I = I + 5
IBL = IBL - 1
IS IBL = 0?
NO
YES
OUTPUT LPBUF TO LINE PRINTER
SET SERVICE BIT FOR ROUTINE H
IS MPOKY = 0?
YES
NO
MPOKY = 0
BIND = BIND + 1
BIND = 6
EXIT TO ROUTINE A

Routine H (Continued)



Routine H (Continued)



Routine H (Concluded)

2.6.15 SUBROUTINE CAL15

2.6.15.1 Purpose

Subroutine CAL15 dedicates the line printer making the system available to print the 15-minute report.

2.6.15.2 Relationship

This subroutine is called by:

```
CALL CAL15
```

The subroutine is called from routines H and I. It returns to the calling routine.

2.6.15.3 Assumption

None.

2.6.15.4 Approach

This subroutine is called only by Routine H in Priority Level 3 and is therefore not required to be re-entrant. It calls on the Real-Time Batch Monitor (RBM) to dedicate the line printer.

2.6.15.5 Listing

See Volume III, 2GCF Routine Listings.

Subroutine CAL15

2.6.16 SUBROUTINE CALRL

2.6.16.1 Purpose

Subroutine CALRL releases the line printer after printing the 15-minute report.

2.6.16.2 Relationship

This subroutine is called by:

```
CALL CALRL
```

This routine is called from routines H and I. It returns to the calling routine.

2.6.16.3 Assumption

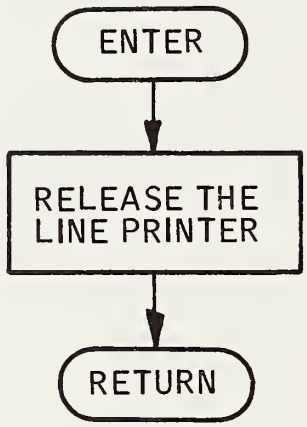
None.

2.6.16.4 Approach

This subroutine is called only by Routine H in Priority Level 3 and is therefore not required to be re-entrant. It calls on the Real-Time Batch Monitor (RBM) to release the line printer.

2.6.16.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine CALRL

2.6.17 SUBROUTINE DECON

2.6.17.1 Purpose

This subroutine takes a scaled binary number and converts it to a whole number then converts the number to a computer code with a period (.) in the last byte.

2.6.17.2 Relationship

Subroutine DECON is called from Routines H, I and subroutine LKDAT by:

CALL DECON (NUM, ISF, IVAL)

where:

NUM = Scaled Binary Number
ISF = Binary Scale Factor
IVAL = Converted number followed by period.

DECON calls E1SRT, GETBY, PTBY.

2.6.17.3 Assumption

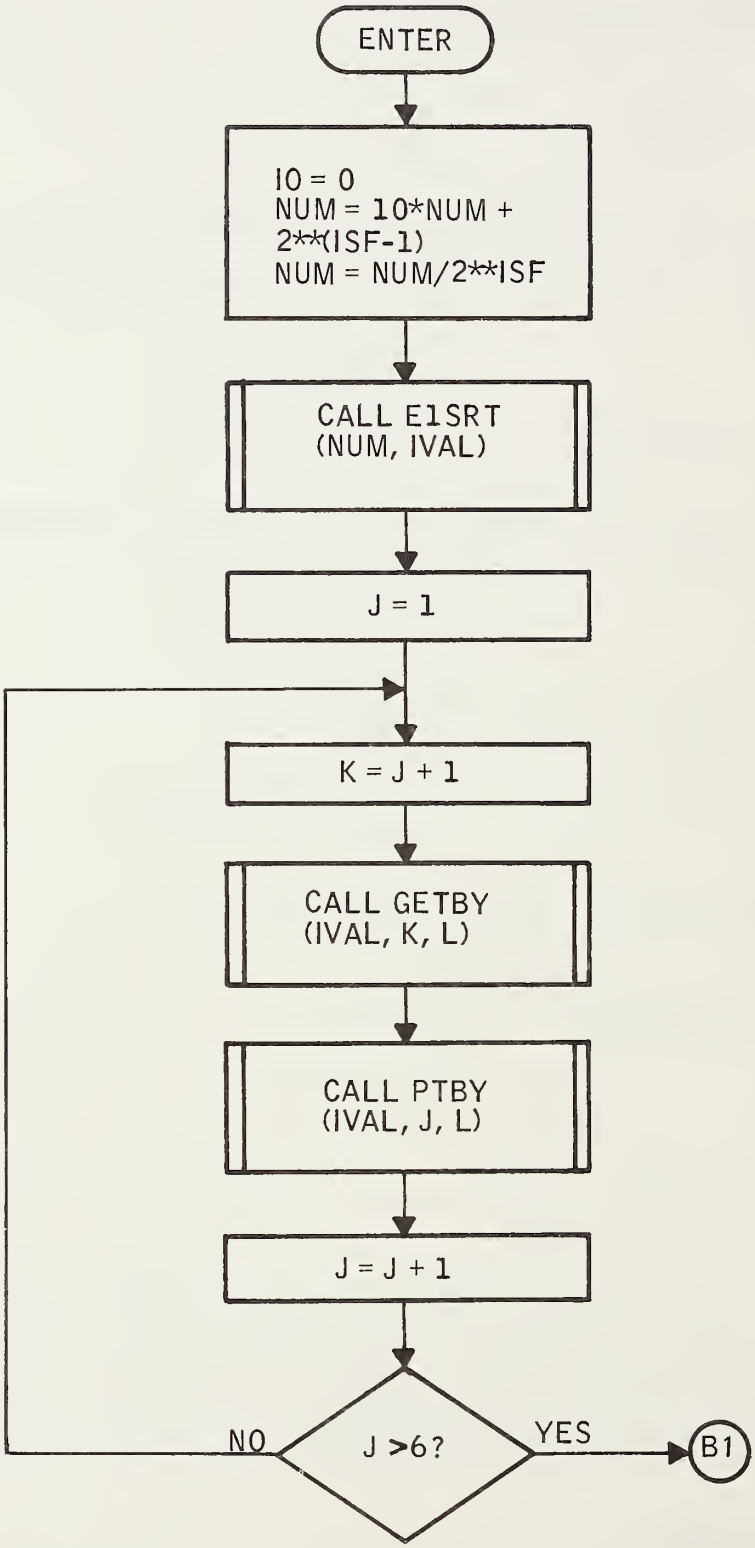
None.

2.6.17.4 Approach

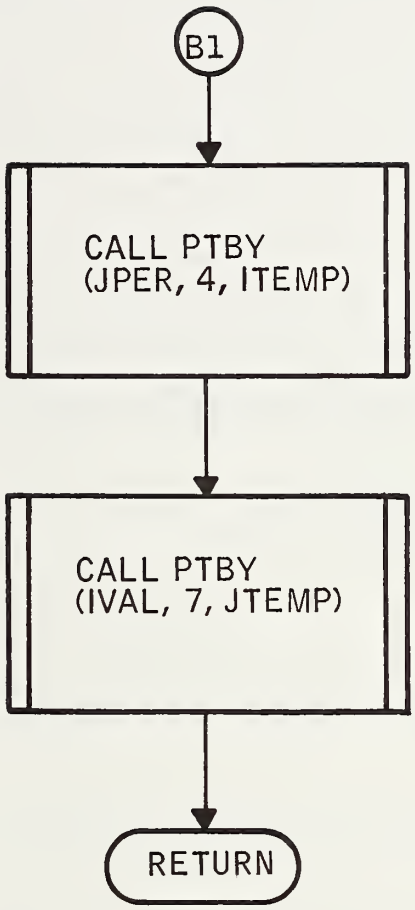
DECON calls Subroutine E1SRT to convert the binary number to computer code. Repeated calls to Subroutine GETBY and PTBY are used to shift the code one byte to the left. The computer code for a period (.) is then stored in the eighth byte. DECON then returns to the calling routine.

2.6.17.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine DECON



Subroutine DECON (Concluded)

2.6.18 SUBROUTINE E1SRT

2.6.18.1 Purpose

This subroutine converts a binary number to ASCII or EBCDIC code. The converted numbers are stored into the array IVAL beginning with the eighth byte in the array and are stored in reverse order with the next character in the seventh byte and so on. The final result will be the converted number stored right adjusted in the first eight bytes of the array.

2.6.18.2 Relationship

This subroutine is called from Routines HFMT, I, LKDAT, OUT2G and STAT by:

```
CALL  E1SRT (INUM, IVAL)
```

where:

INUM = binary number scaled at BO
IVAL = converted characters from binary number.

in addition, the following are found in COMMON block BLK15:

CHSET = 30 defines ASCII character set.

CHSET = 40 defines EBCDIC character set.

NBMCH = 16 defines 16-bit machine.

NBMCH = 24 defines 24-bit machine.

NBMCH = 32 defines 32-bit machine.

E1SRT calls PTBYT, GETBY.

2.6.18.3 Assumption

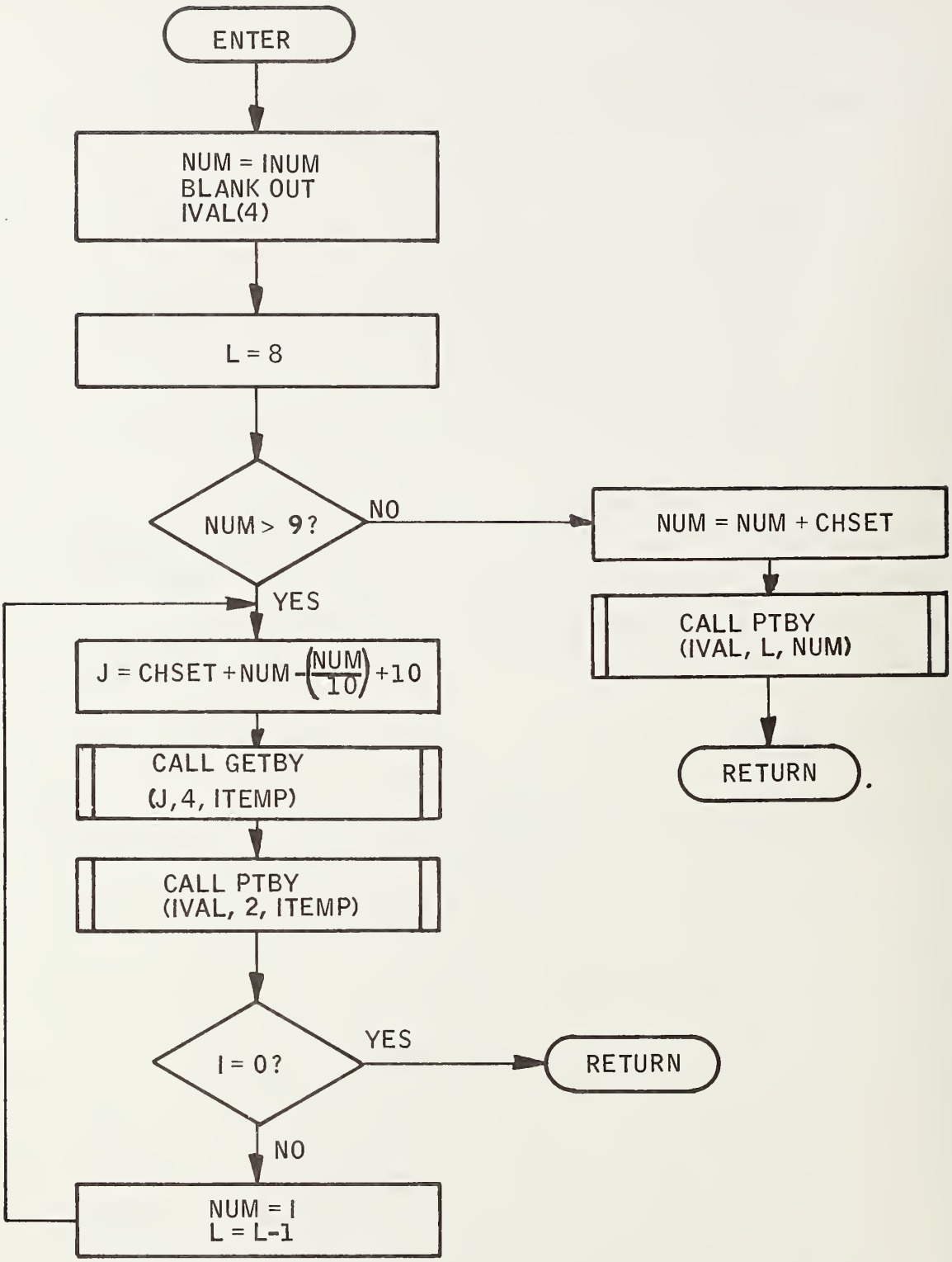
None.

2.6.18.4 Approach

E1SRT converts a binary number to machine code (ASCII or EBCDIC) by isolating the digits, adding the offset CHSET, and storing the results into the IVAL array. It begins with the least significant digit storing that in the last byte. Upon completion, E1SRT returns to the calling routine.

2.6.18.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine E1SRT

2.6.19 SUBROUTINE LKDAT

2.6.19.1 Purpose

To output link data, such as accumulated volume, occupancy, average speed, travel time, and delay into the tape buffer and to the line printer.

2.6.19.2 Relationship

Called from Routine H by:

```
CALL LKDAT (IRET)
```

where:

IRET = return status
= 0 for process complete
= 1 for process remains to be completed.

2.6.19.3 Assumption

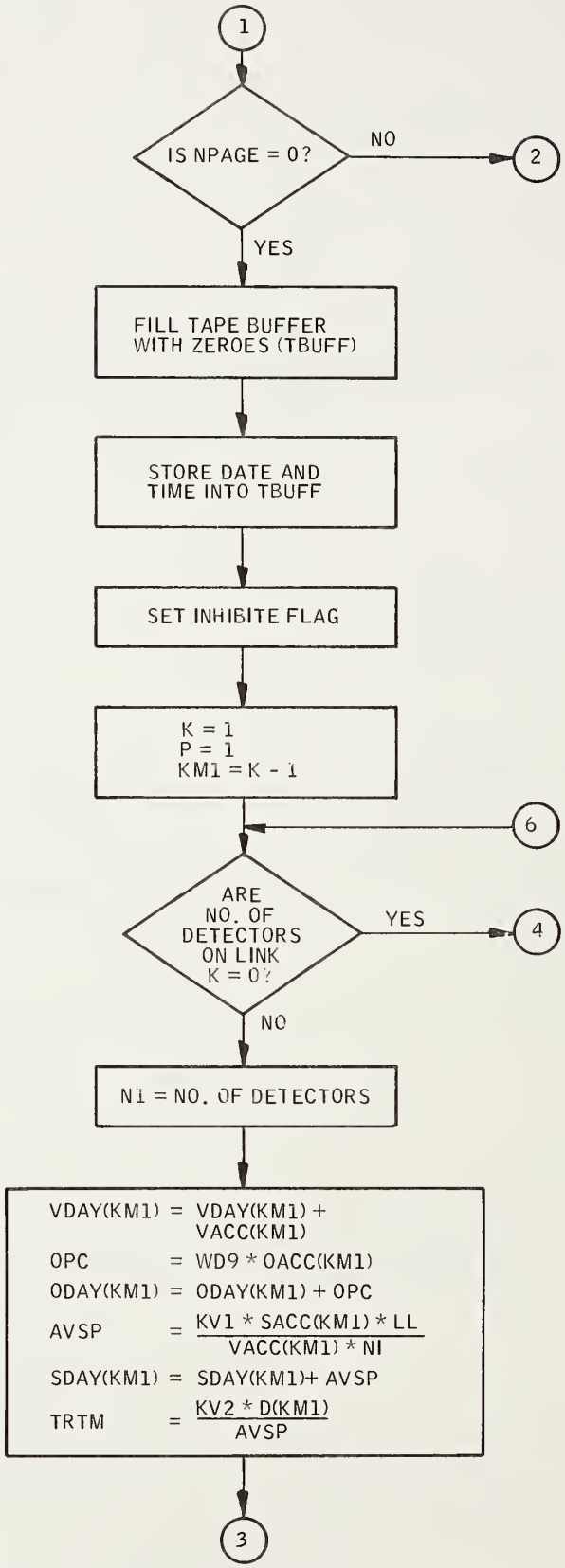
None.

2.6.19.4 Approach

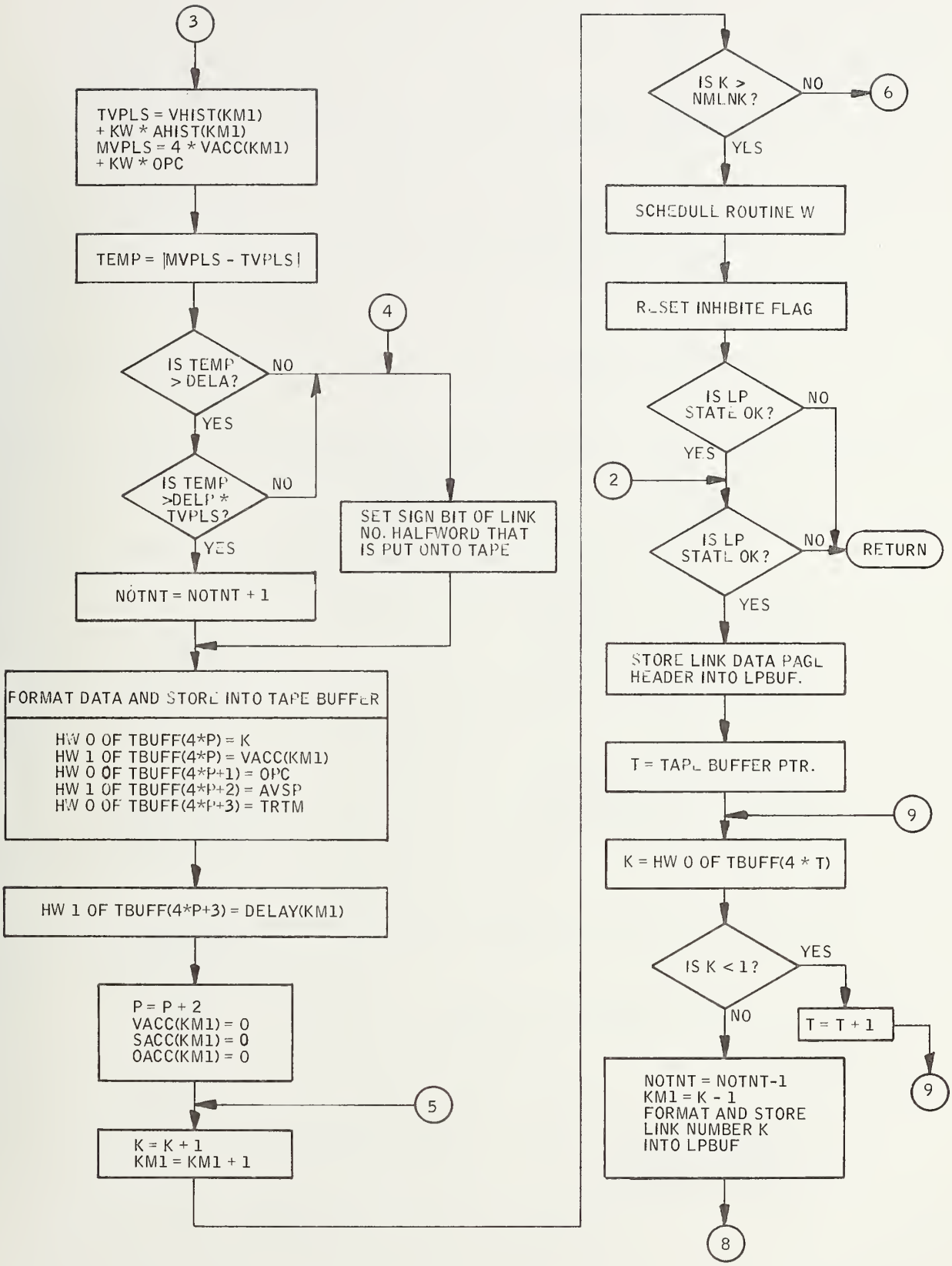
Subroutine LKDAT fills the buffer TBUFF according to the format specified by Subroutine OUTAP.

2.6.19.5 Listing

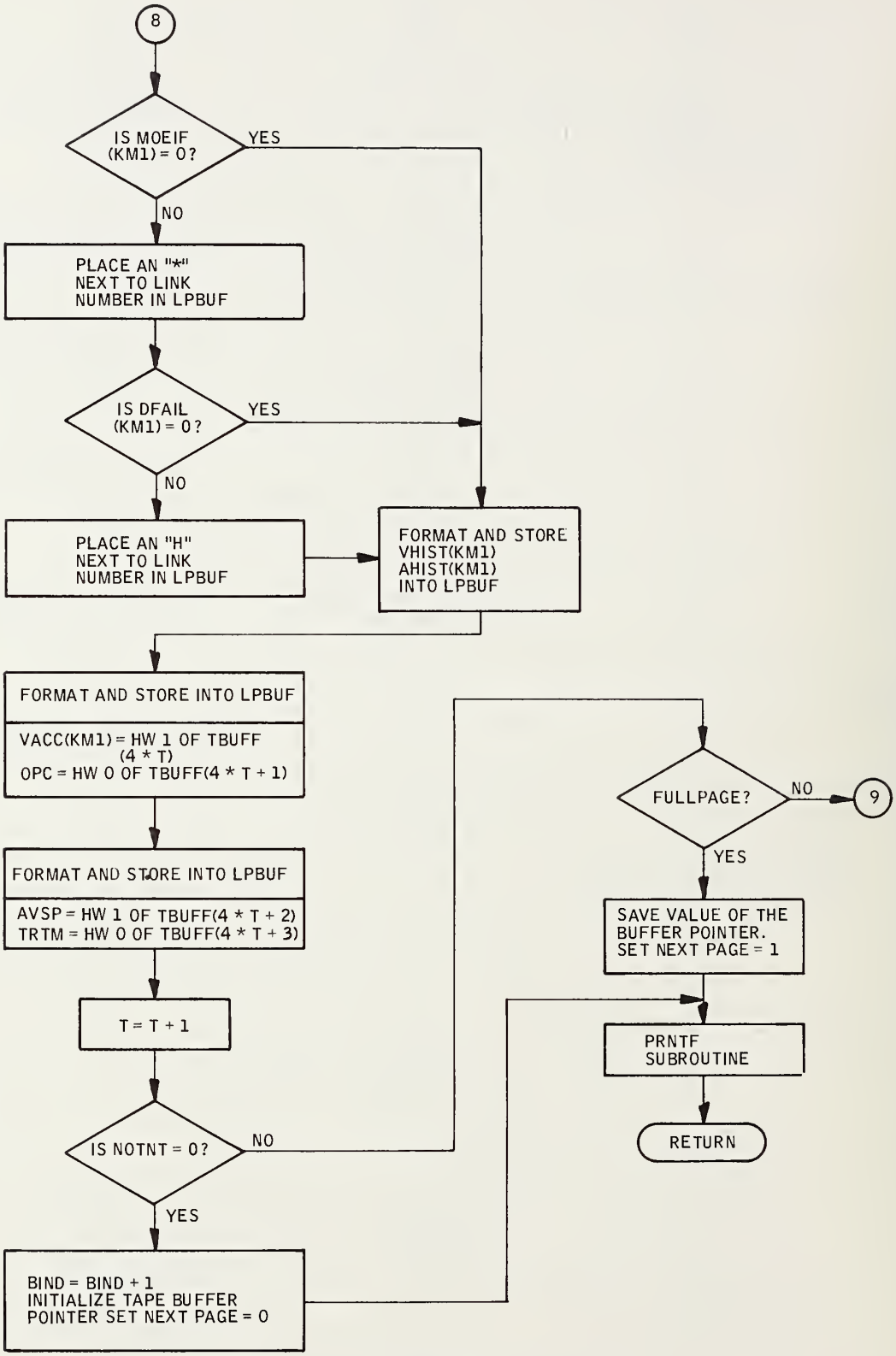
See Volume III, 2GCF Routine Listings.



Subroutine LKDAT



Subroutine LKDAT (Continued)


8
IS MOEIF (KM1) = 0?
YES
NO
PLACE AN "*" NEXT TO LINK NUMBER IN LPBUF
IS DFAIL (KM1) = 0?
YES
NO
PLACE AN "H" NEXT TO LINK NUMBER IN LPBUF
FORMAT AND STORE VHIST(KM1) AHIST(KM1) INTO LPBUF
FORMAT AND STORE INTO LPBUF
VACC(KM1) = HW 1 OF TBUFF (4 * T)
OPC = HW 0 OF TBUFF(4 * T + 1)
FORMAT AND STORE INTO LPBUF
AVSP = HW 1 OF TBUFF(4 * T + 2)
TRTM = HW 0 OF TBUFF(4 * T + 3)
T = T + 1
IS NOTNT = 0?
NO
YES
BIND = BIND + 1
INITIALIZE TAPE BUFFER POINTER SET NEXT PAGE = 0
FULLPAGE?
NO
9
YES
SAVE VALUE OF THE BUFFER POINTER. SET NEXT PAGE = 1
PRNTF SUBROUTINE
RETURN

Subroutine LKDAT (Concluded)

2.6.20 SUBROUTINE MHEAD

2.6.20.1 Purpose

This subroutine loads the main header into LPBUFF.

2.6.20.2 Relationship

This subroutine is called from Subroutine STAT by the following command:

```
CALL MHEAD
```

It calls STMSG, PTBY. It returns to the calling routine.

2.6.20.3 Assumption

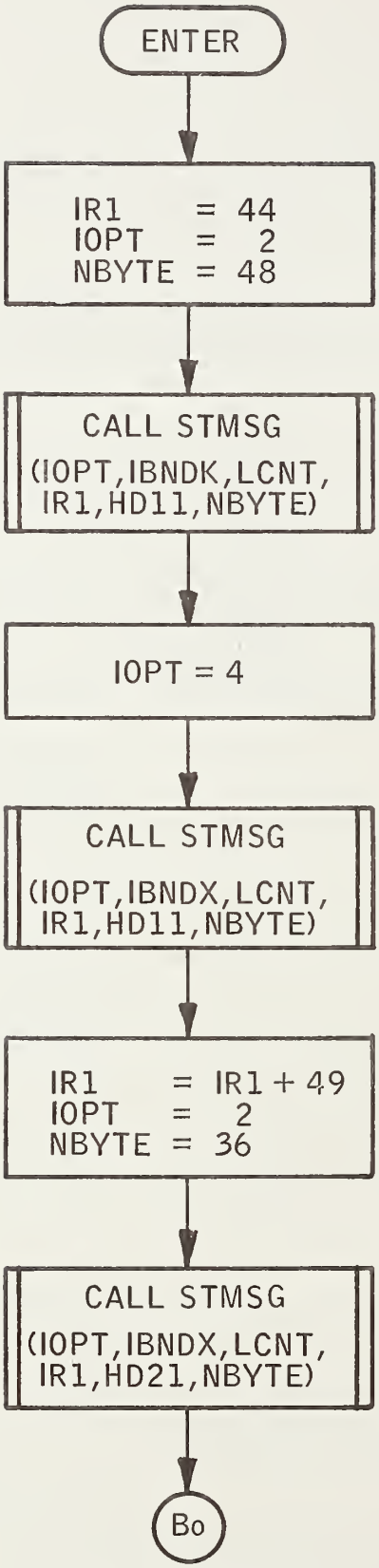
None.

2.6.20.4 Approach

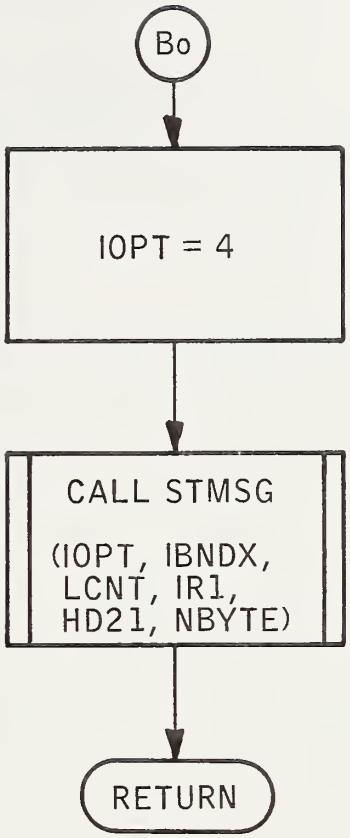
Subroutine MHEAD copies the 2 lines of the main header into the line printer buffer (LPBUFF).

2.6.20.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine MHEAD



Subroutine MHEAD (Concluded)

2.6.21 SUBROUTINE OUTAP

2.6.21.1 Purpose

Subroutine OUTAP outputs the 15-minute Measures of Effectiveness (MOE) data on an output tape (Figure 8).

2.6.21.2 Relationship

This subroutine is called from Routine H by:

```
CALL OUTAP (IERR)
```

where:

IERR is the mnemonic:

IERR = Tape write error indicator
= 1 for error
= 0 for no error

It returns to the calling routine.

2.6.21.3 Assumption

None.

2.6.21.4 Approach

This subroutine is called only by Routine H and is therefore not required to be re-entrant. It may call Subroutine TSTAP (also non-re-entrant) to test the status of the tape. It writes the tape buffer (TBUFF) to the tape (see Routine H).

2.6.21.5 Listing

See Volume III, 2GCF Routine Listings.

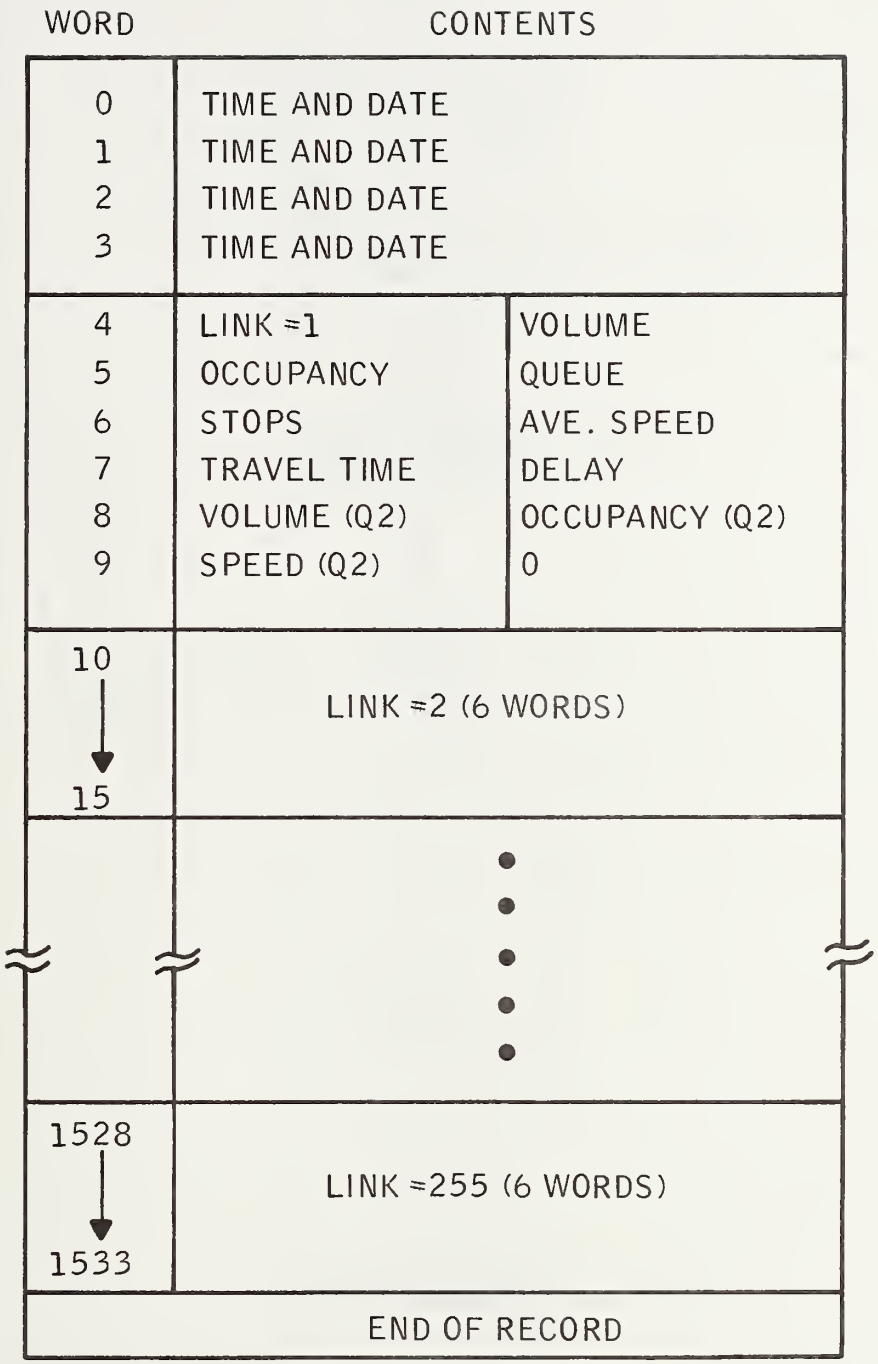
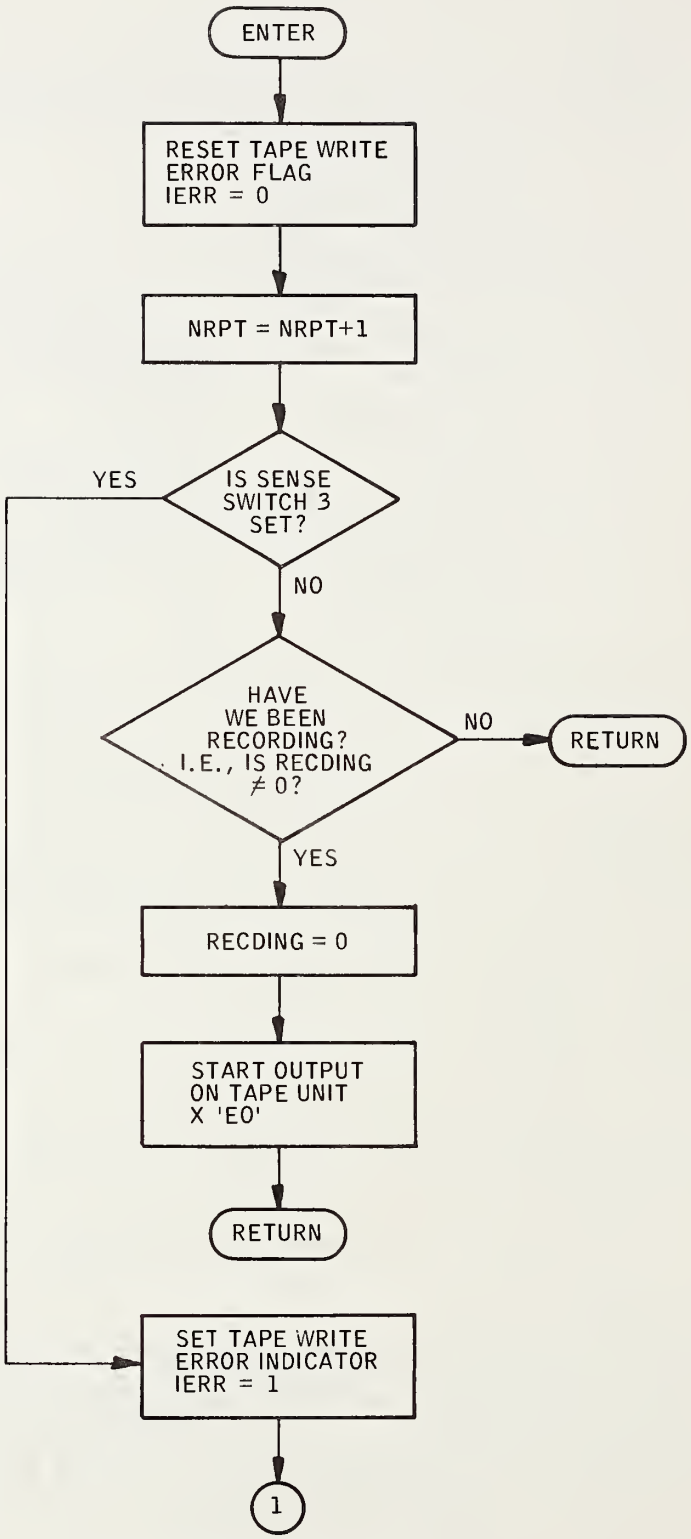
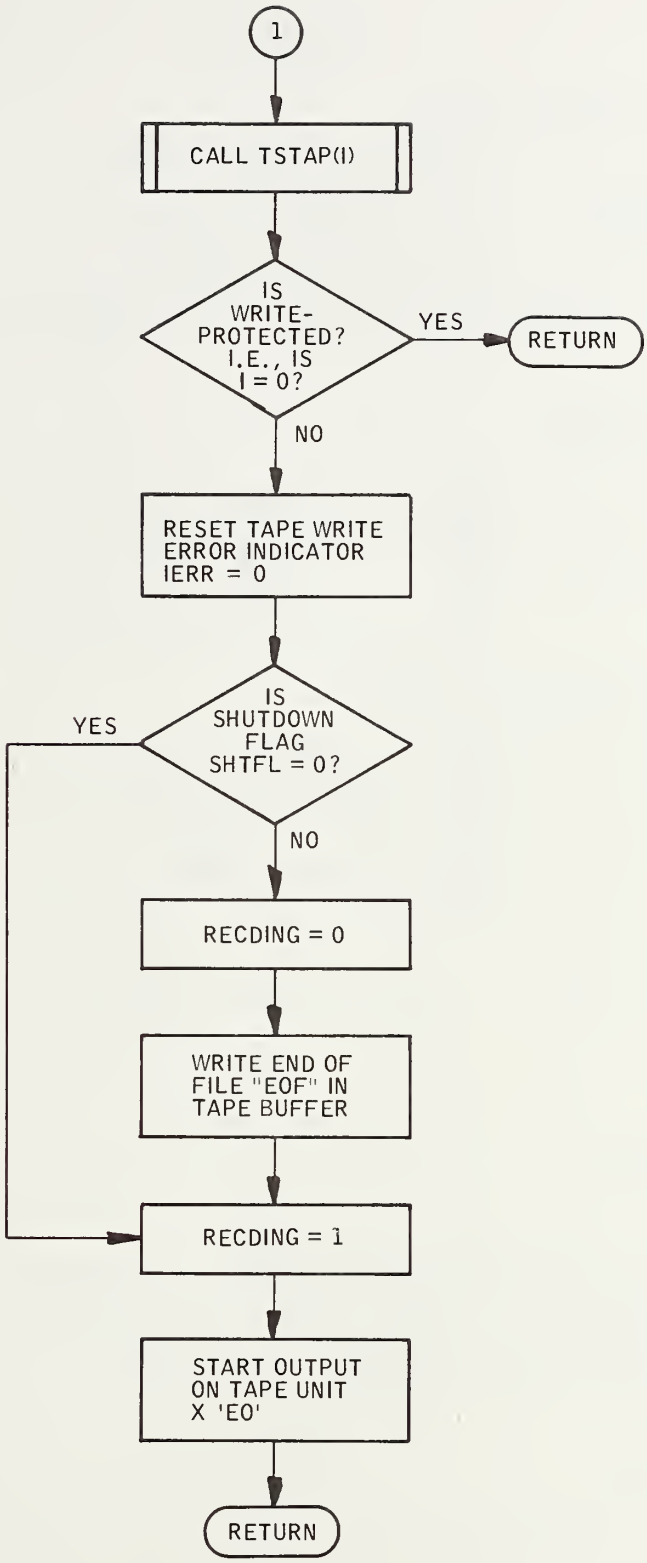


Figure 8. 15-Minute Measure of Effectiveness (MOE) Tape Format



Subroutine OUTAP



Subroutine OUTAP (Concluded)

2.6.22 SUBROUTINE OUT2G

2.6.22.1 Purpose

This subroutine outputs intersection information via the line printer.

2.6.22.2 Relationship

OUT2G is called from Routine H by:

CALL OUT2G (II, IOPF)

where:

II = intersection number

IOPF = return status

= 0 for process completed

= 1 for return to complete process

2.6.22.3 Assumption

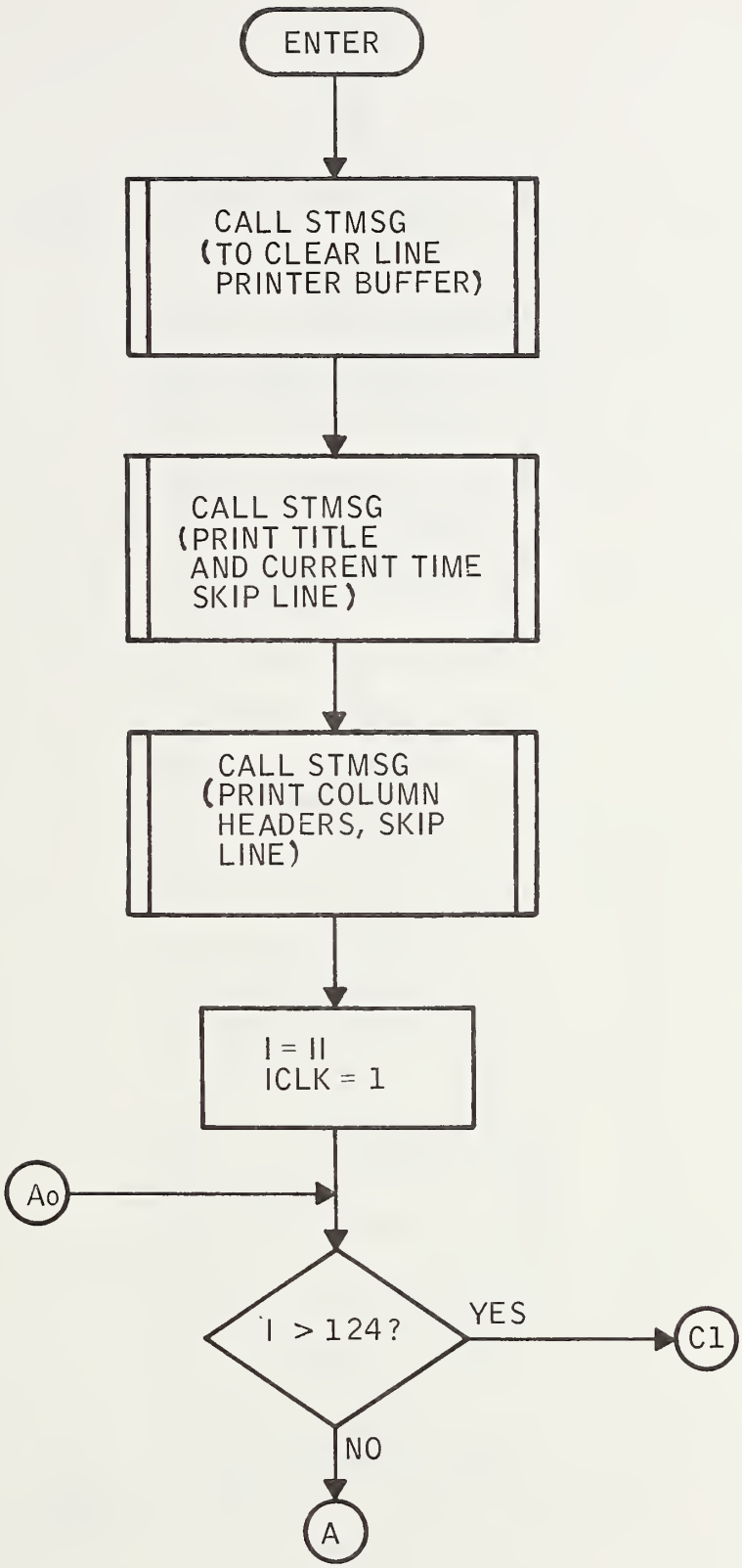
None.

2.6.22.4 Approach

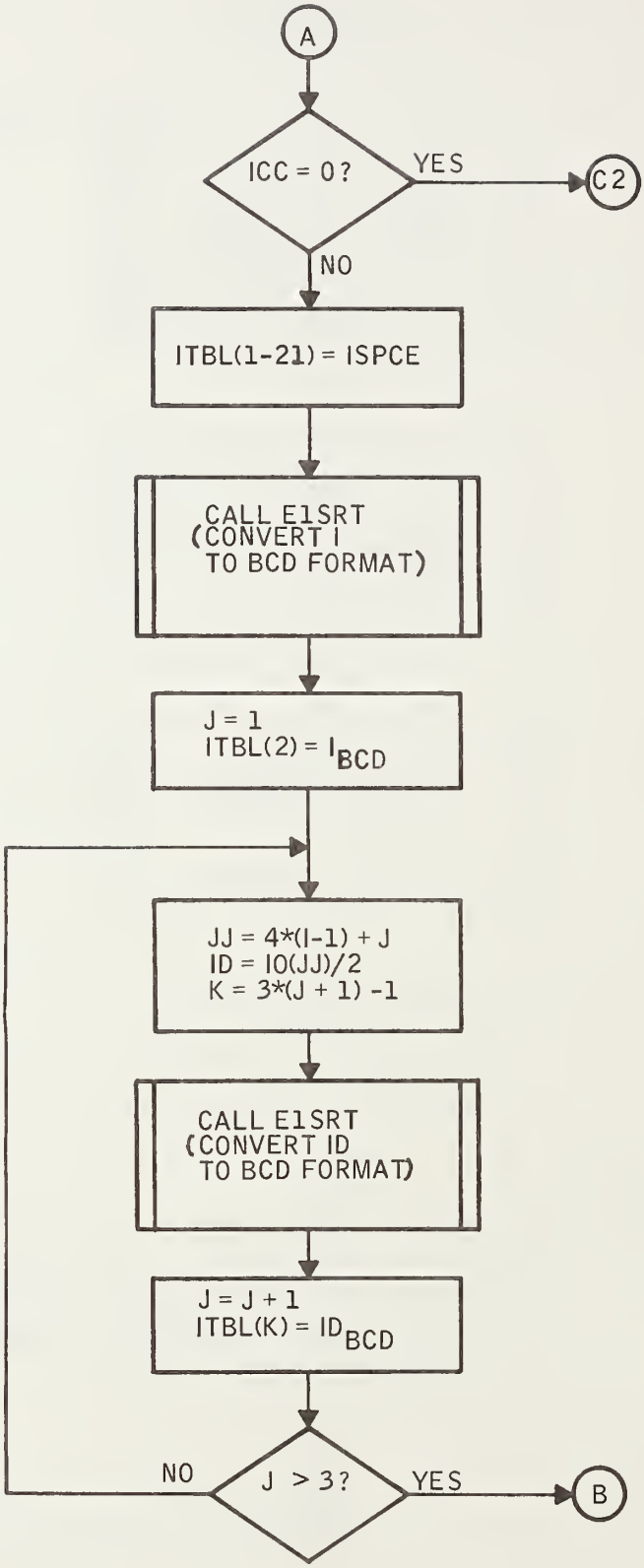
Subroutine OUT2G clears the output buffer, then places a page header followed by such information as the various phase offsets, cycle length, and which core group this intersection is associated with.

2.6.22.5 Listing

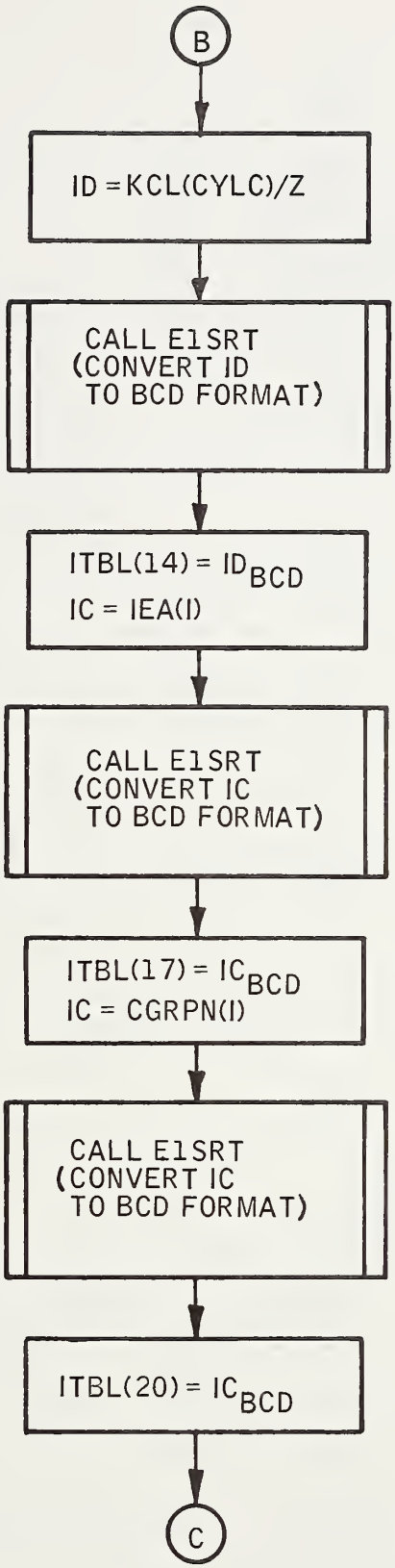
See Volume III, 2GCF Routine Listings.



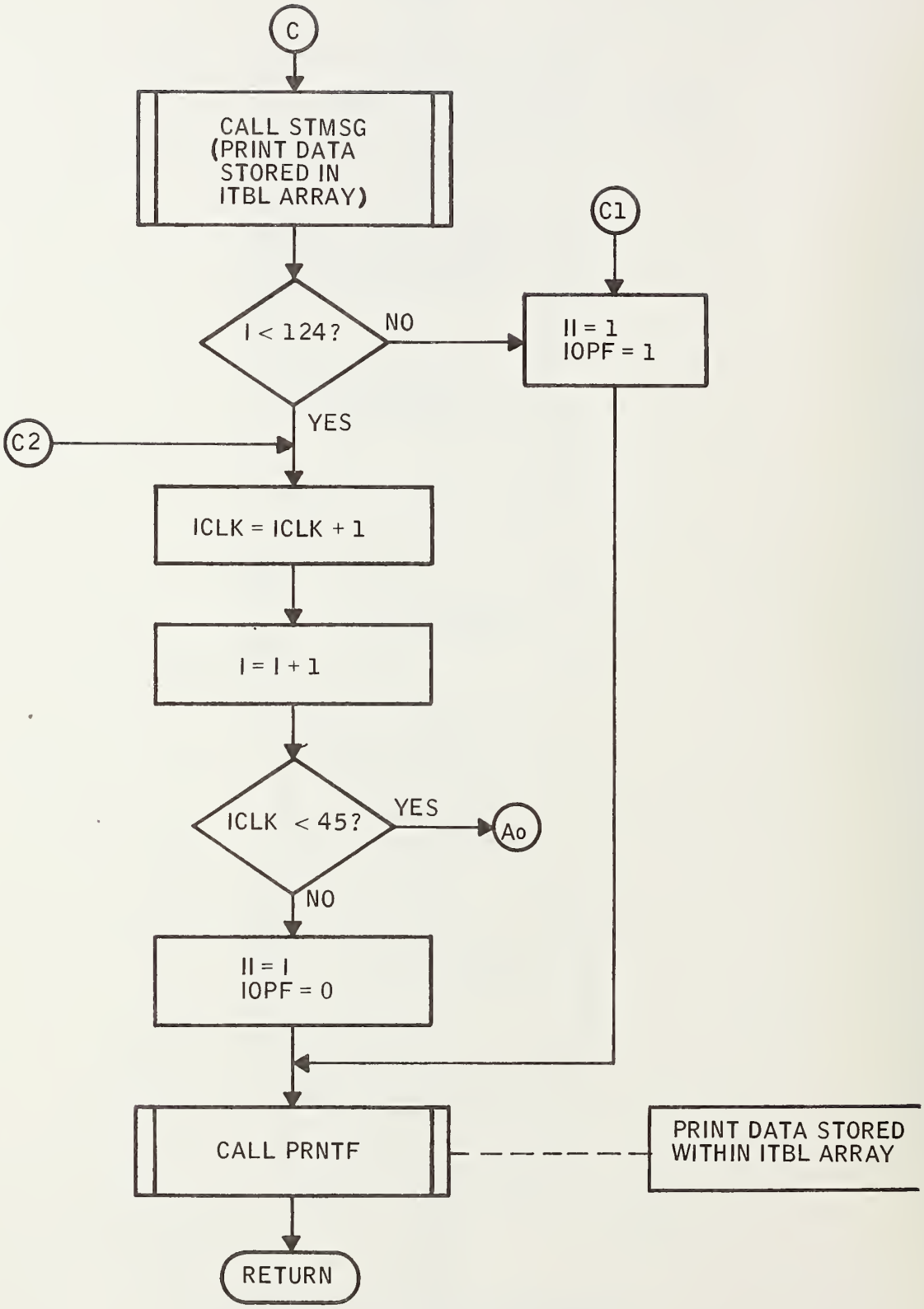
Subroutine OUT2G



Subroutine OUT2G (Continued)



Subroutine OUT2G (Continued)



Subroutine OUT2G (Concluded)

2.6.23 SUBROUTINE PRNTF

2.6.23.1 Purpose

The purpose of Subroutine PRNTF is to print a page of output data from the line printer buffer.

2.6.23.2 Relationship

This routine is called from Routine H and Subroutines LKDAT, and OUT2G by:

```
CALL PRNTF (LCNT)
```

where:

LCNT is the mnemonic:

LCNT = Number of lines to be printed.

2.6.23.3 Assumption

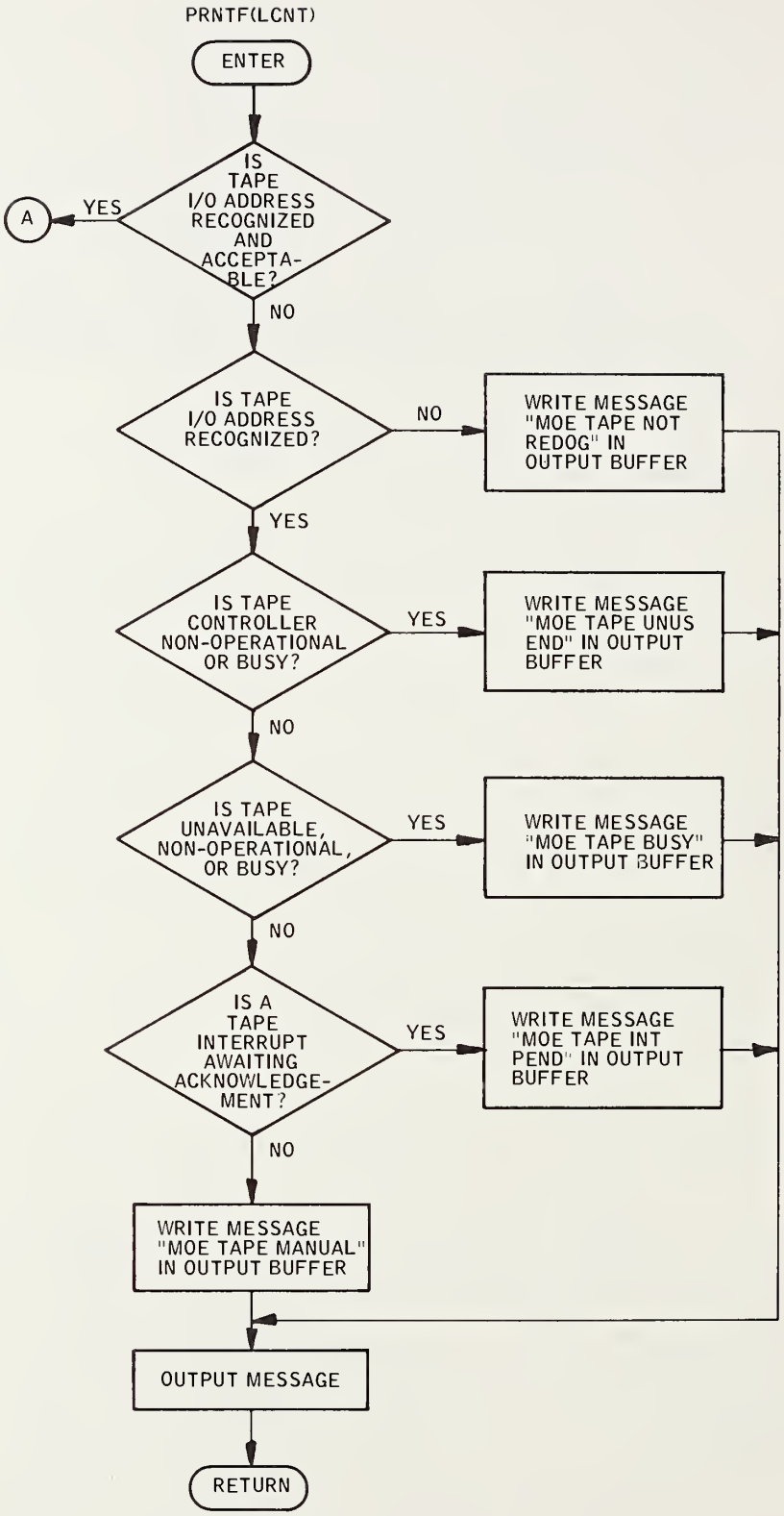
None.

2.6.23.4 Approach

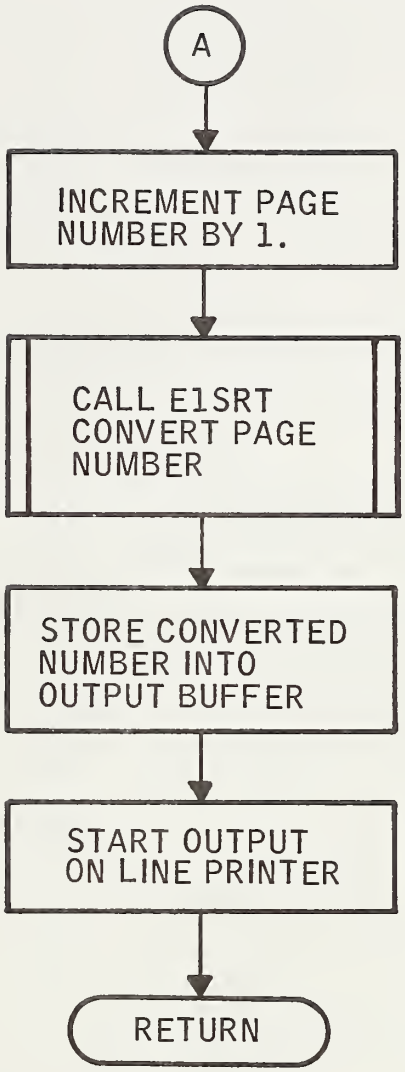
This subroutine is called by Routine H. Subroutines LKDAT and OUT2G are also called by Routine H. Since these have the same priority level, it is not required that Subroutine PRNTF be re-entrant.

2.6.23.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine PRNTF



Subroutine PRNTF (Concluded)

2.6.24 SUBROUTINE SBYTC

2.6.24.1 Purpose

This subroutine performs a circular shift on 8 bytes of data.

2.6.24.2 Relationship

This subroutine is called from Routine I and Subroutine STAT by:

```
CALL SBYTC (A, N)
```

where:

A = First byte of an 8 byte array. Must be on word boundary.
N = No. of bytes to shift to the left. If N is negative the shift is to the right. -4. LE. N . LE. 4

SBYTC calls GETBY, PTBY.

2.6.24.3 Assumption

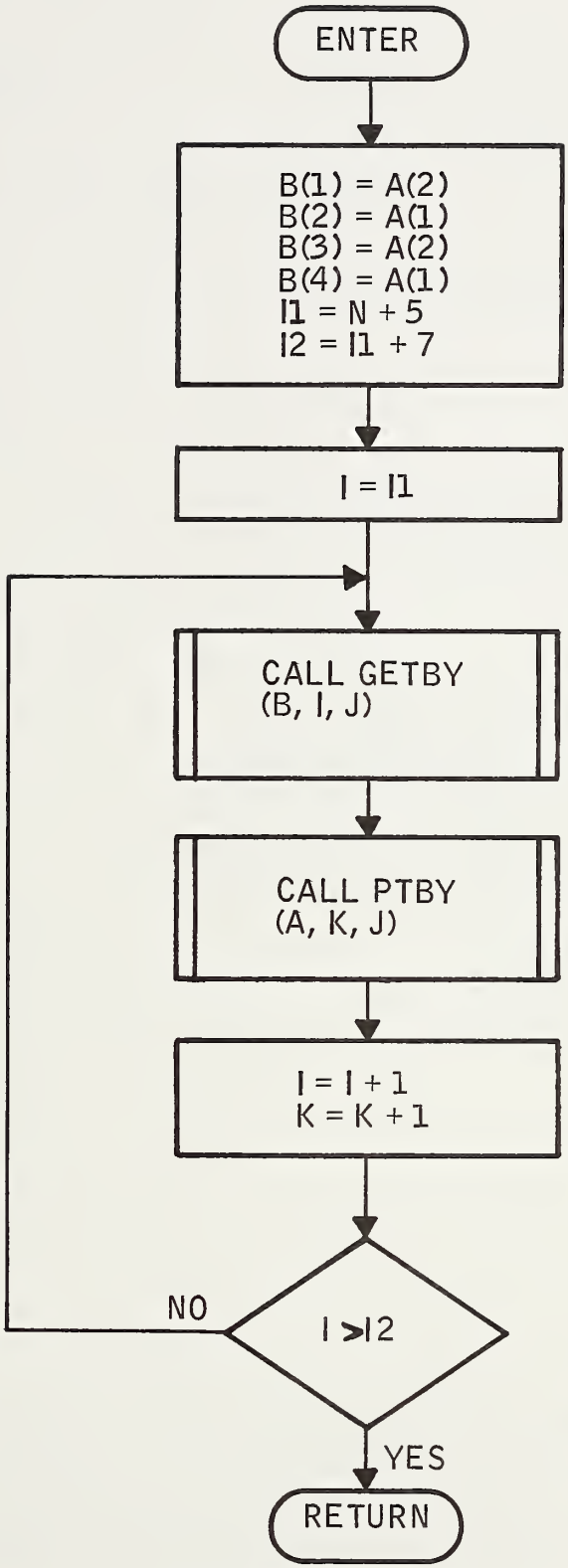
None.

2.6.24.4 Approach

The bytes of the specified word are unpacked by subroutine GETBY, then repacked in their 'shifted' position by calls to subroutine PTBY. SBYTC then returns to the calling routine.

2.6.24.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine SBYTC

2.6.25 SUBROUTINE STAT

2.6.25.1 Purpose

This subroutine prints system statistics.

2.6.25.2 Relationship

This subroutine is called from Routine H by:

```
CALL STAT (JOPT, IRET)
```

where:

JOPT = program control flag.
= 1 for print failure status page
= 2 for print controller status page
= 3 for print detector status page
= 4 for print system status page

IRET = return status
= 1 for completed
= 2 for not completed

2.6.25.3 Assumption

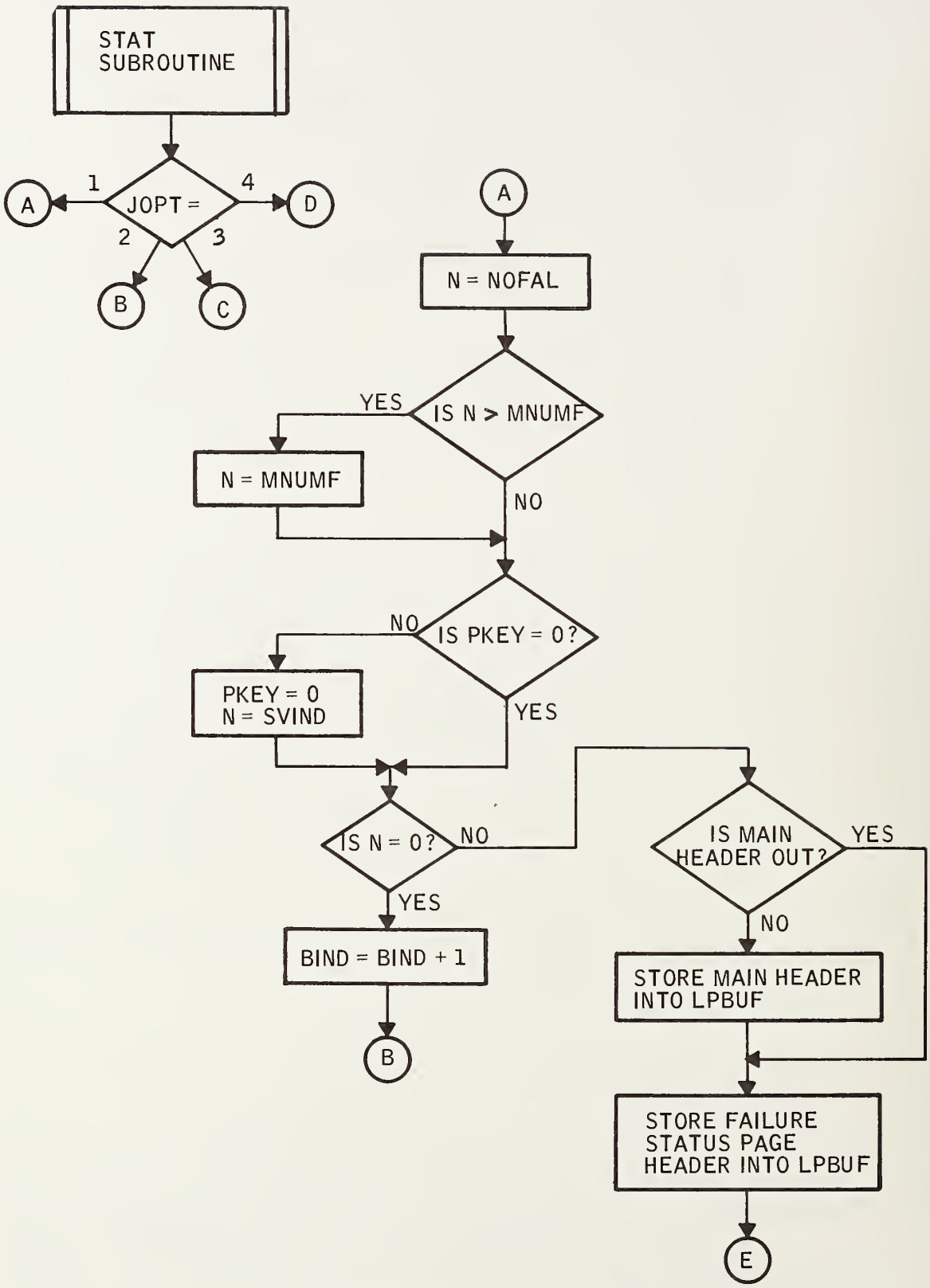
None.

2.6.25.4 Approach

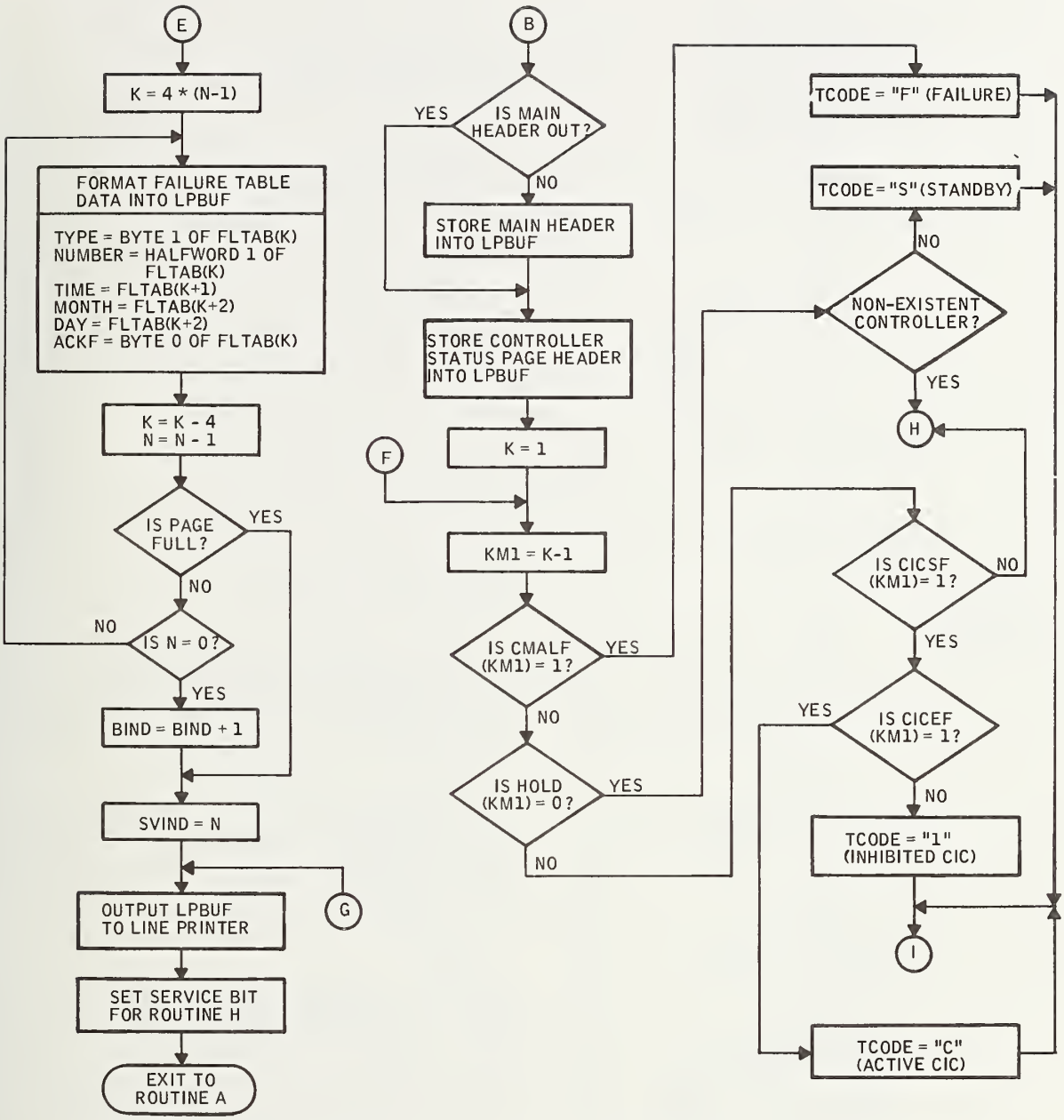
Subroutine STAT is entered from Routine H. Upon entry, if the main header has not been placed in LPBUF, then this is done. The header for the type of status page (failure, controller, detector, or system) is then placed in LPBUF. The appropriate data is then formatted into LPBUF. STAT returns to Routine H.

2.6.25.5 Listing

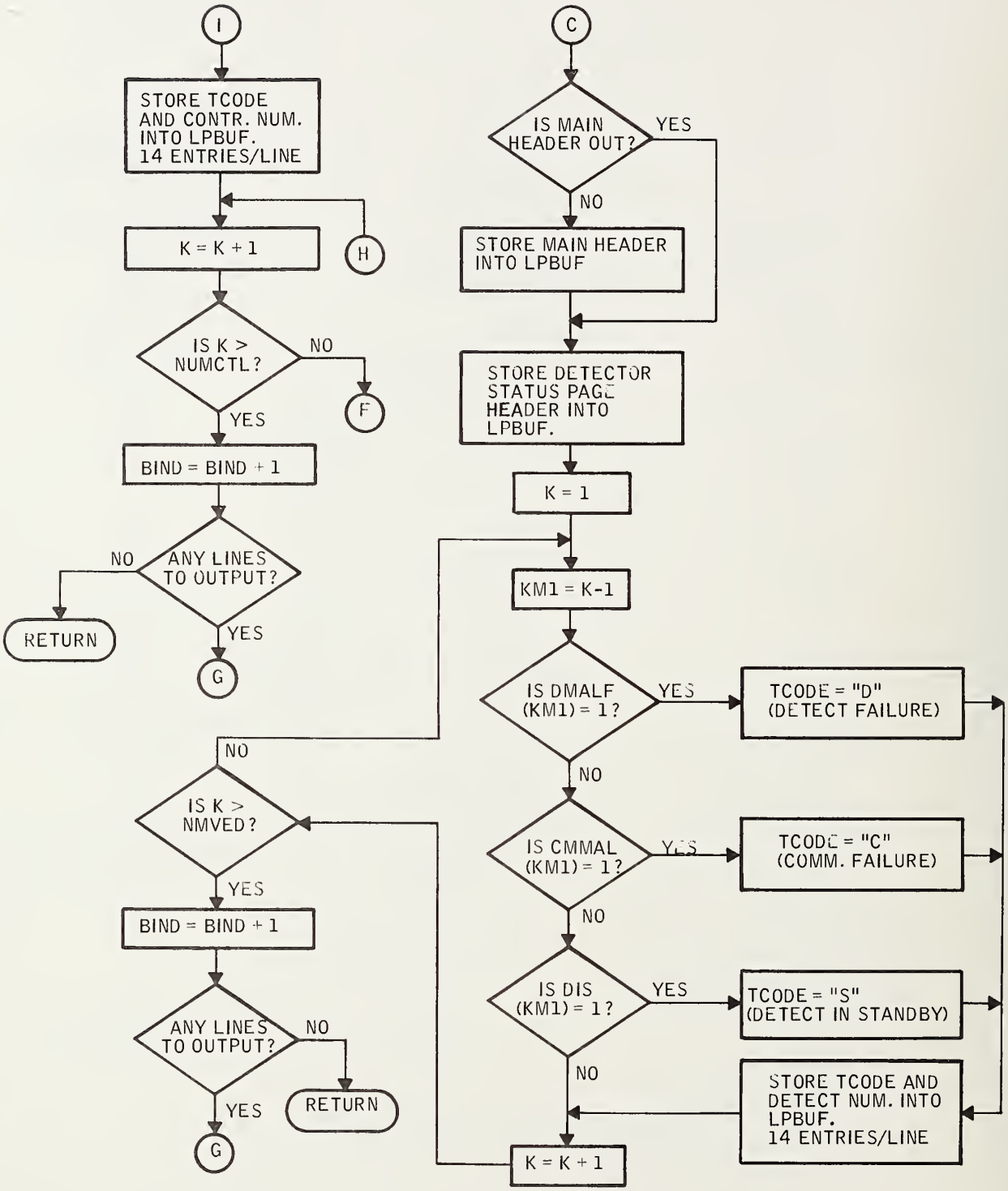
See Volume III, 2GCF Routine Listings.



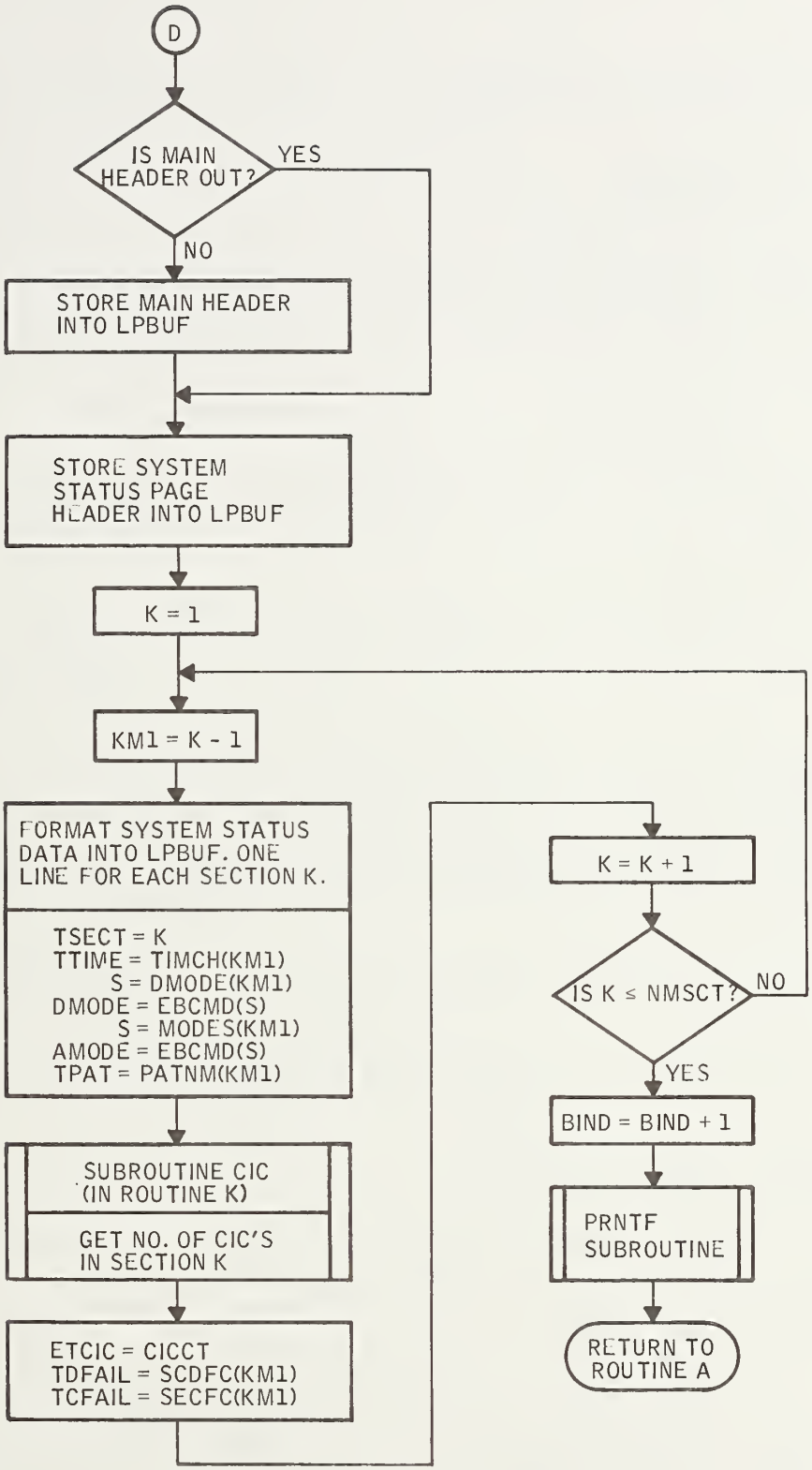
Subroutine STAT



Subroutine STAT (Continued)



Subroutine STAT (Continued)



Subroutine STAT (Concluded)

2.6.26 SUBROUTINE STMSG

2.6.26.1 Purpose

Subroutine STMSG stores message into LPBUF. This routine also will space one line or load the line printer buffer (LPBUF) with blanks.

2.6.26.2 Relationship

This subroutine is called from Routines H, I, LKDAT, MHEAD, OUT2G, and STAT by:

CALL STMSG (IOPT, IBNDX, LCNT, LNDEX, MESSG, or NBYTE)

where:

Input

IOPT = 1 Number of bytes in message is obtained from first byte in message.

= 2 Number of bytes in message is in calling sequence.

= 3 Only a partial line is to be output, LCNT and IBNDX are not incremented.

IOPT = 4 Space one line

IOPT = 5 Set LPBUF to blanks

IBNDX = BUF index.

LCNT = Line count.

LNDEX = LPBUF index.

MESSG = Contains message to be output.

NBYTE = Number of bytes to be output.

Output

LCNT = Current line count

IBNDX = Current BUF index

LNDEX = Current LPBUF index

2.6.26.3 Assumption

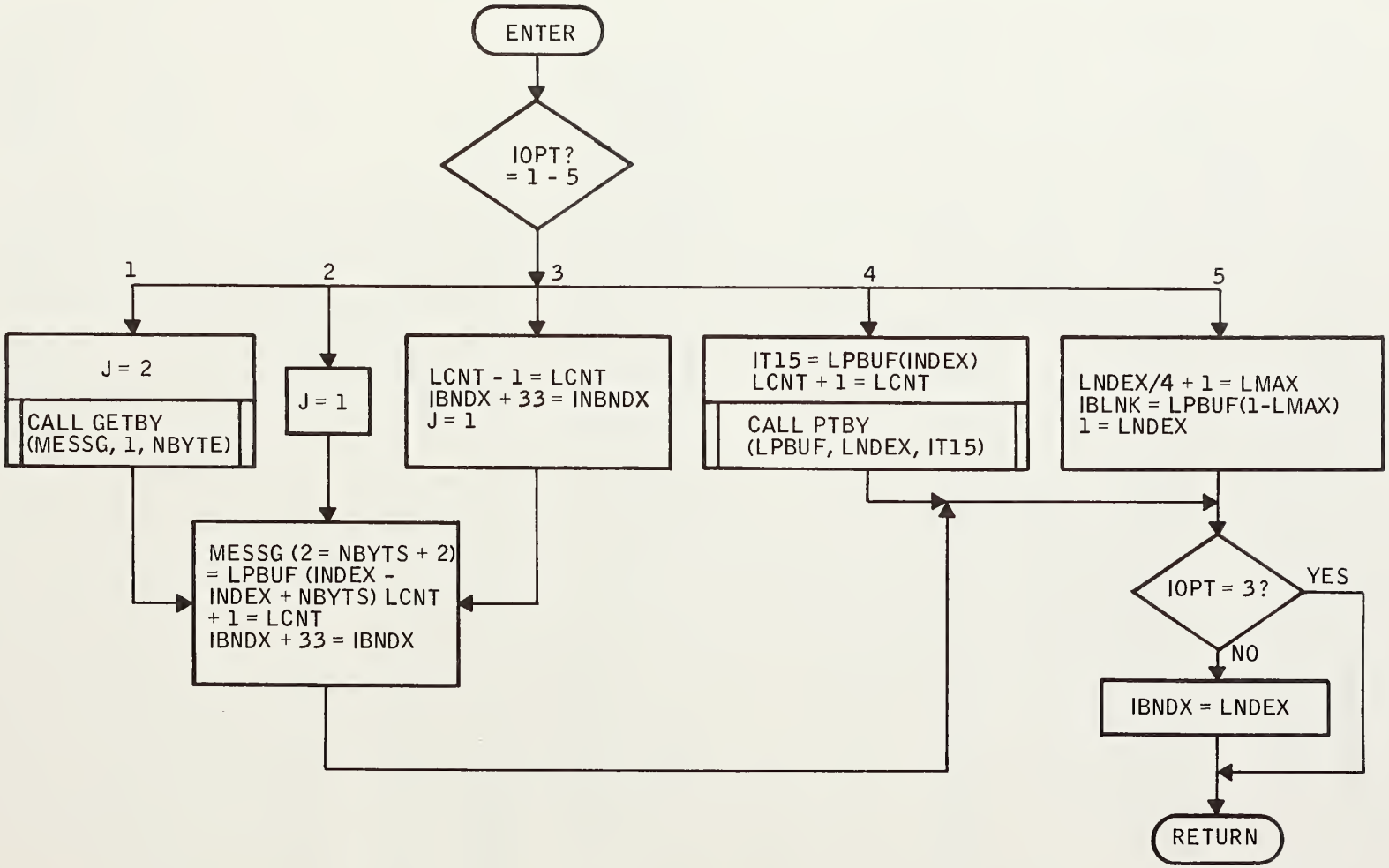
None.

2.6.26.4 Approach

Subroutine STMSG transfers the specified character string to the line printer buffer (LPBUFF). The current line count, the BUF index and the LPBUF index are incremented when appropriate. Subroutine STMSG returns to the calling routine.

2.6.26.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine STMSG

2.6.27 SUBROUTINE TIMEH

2.6.27.1 Purpose

Subroutine TIMEH reads alphanumeric data (EBCDIC code) from the RBM clock and repacks it into the array IBUF.

2.6.27.2 Relationship

This subroutine is called from Routines H, I, HFMT, or OUT2G by:

```
CALL TIMEH (IBUF)
```

where:

IBUF is the mnemonic:

IBUF (4 words) =

Words	Bytes 0	1	2	3	
1		m	o	n	three letter EBCDIC code for month
2		d	d		two digit EBCDIC code for day
3	y	y			two digit EBCDIC code for year
4	h	h	m	m	two digit EBCDIC code for each of hour and minute

2.6.27.3 Assumption

None.

2.6.27.4 Approach

This subroutine is called by Routine H in Priority Level 3 and is therefore not required to be re-entrant.

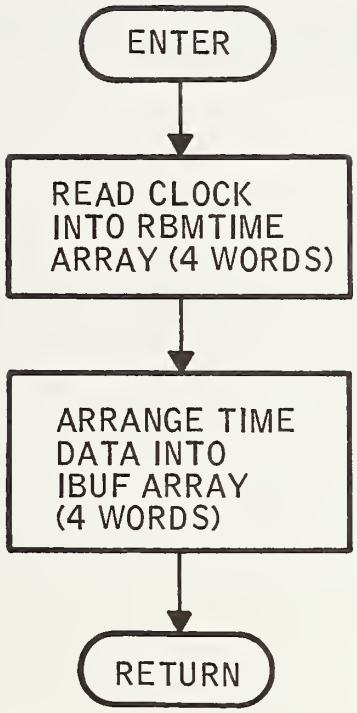
The four words initially read into the system real time clock (RBMTIME) from the monitor consist of:

Words \ Bytes	0	1	2	3
1	h	h	:	m
2	m		m	o
3	n		d	d
4	'	'	y	y

(EBCDIC code)

2.6.27.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine TIMEH

2.6.28 SUBROUTINE TSTAP

2.6.28.1 Purpose

Subroutine TSTAP tests the status of the Measures of Effectiveness (MOE) tape before an effort is made to write on it.

2.6.28.2 Relationship

This subroutine is called from subroutine OUTAP by:

```
CALL TSTAP (I)
```

where:

I is the mnemonic:

I = Tape write protected error indicator.

2.6.28.3 Assumption

None.

2.6.28.4 Approach

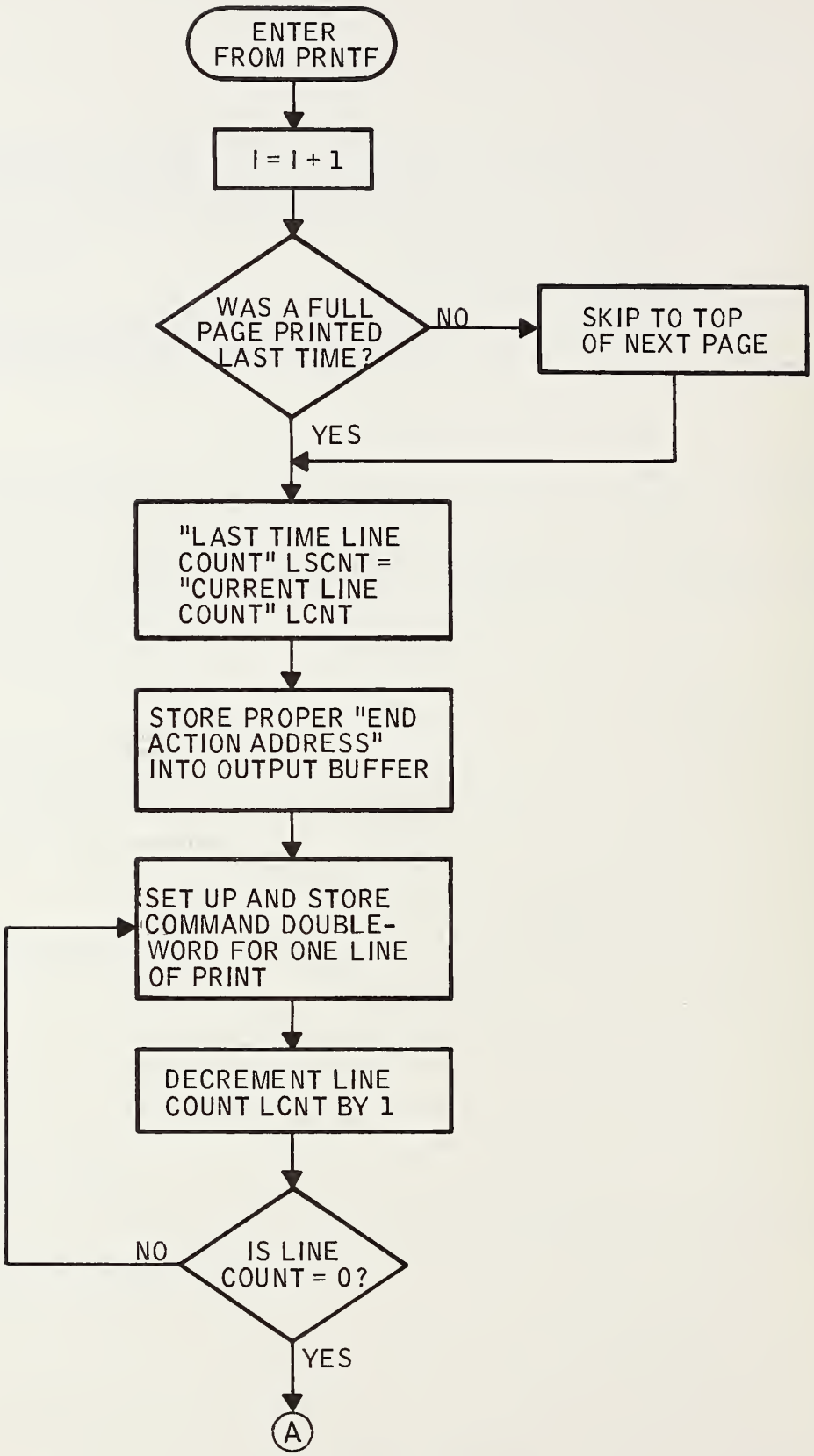
This subroutine is called only from Subroutine OUTAP and is therefore not required to be re-entrant.

It should be noted that since OUTAP is an assembly language routine the above FORTRAN call is not found in the program listing. An equivalent assembly language call is used.

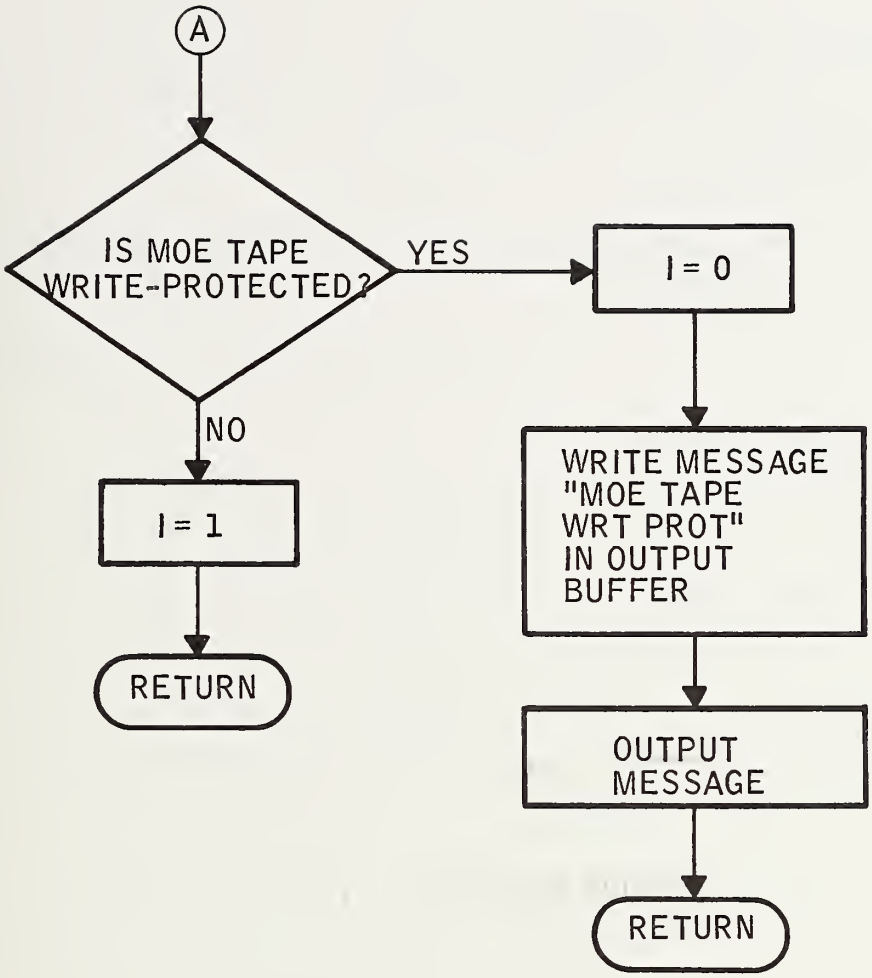
If an error condition exists, an appropriate message is printed on the teletype.

2.6.28.5 Listing

See Volume III, 2GCF Routine Listings.


ENTER FROM PRNTF
I = I + 1
WAS A FULL PAGE PRINTED LAST TIME?
NO
SKIP TO TOP OF NEXT PAGE
YES
"LAST TIME LINE COUNT" LSCNT = "CURRENT LINE COUNT" LCNT
STORE PROPER "END ACTION ADDRESS" INTO OUTPUT BUFFER
SET UP AND STORE COMMAND DOUBLE-WORD FOR ONE LINE OF PRINT
DECREMENT LINE COUNT LCNT BY 1
NO
IS LINE COUNT = 0?
YES
A

Subroutine TSTAP



Subroutine TSTAP (Concluded)

2.6.29 SUBROUTINE TSTLP

2.6.29.1 Purpose

Subroutine TSTLP tests the status of the line printer before an attempt is made to print.

2.6.29.2 Relationship

This subroutine is called from Routines H, I, and LKDAT by:

```
CALL TSTLP (IERR)
```

where:

IERR is the mnemonic:

IERR = Error indicator

= 1 for error

= 0 for no error

2.6.29.3 Assumption

None.

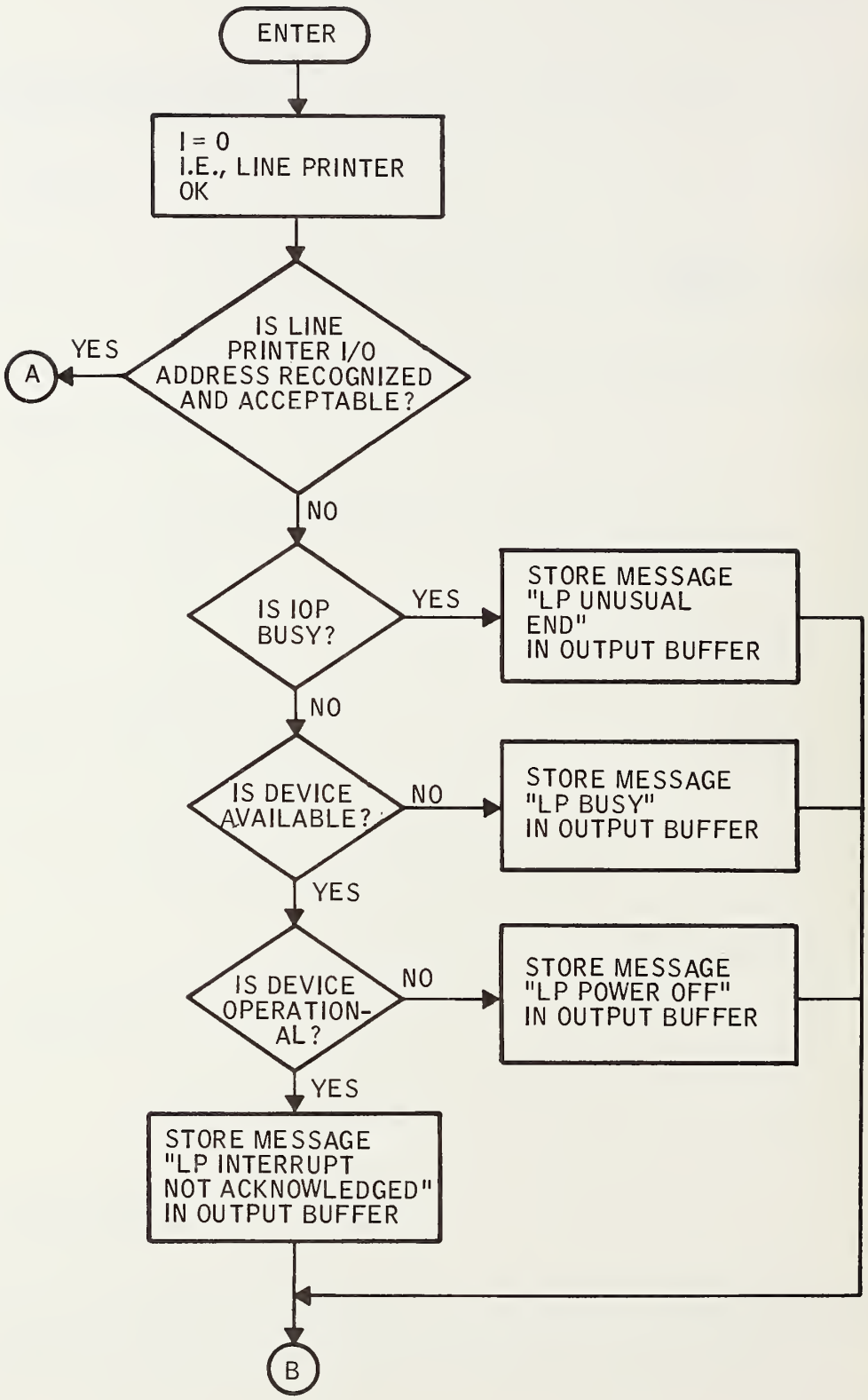
2.6.29.4 Approach

This subroutine is called by Routines H, I and LKDAT. Since these have the same priority level, it is not required that Subroutine TSTLP be re-entrant.

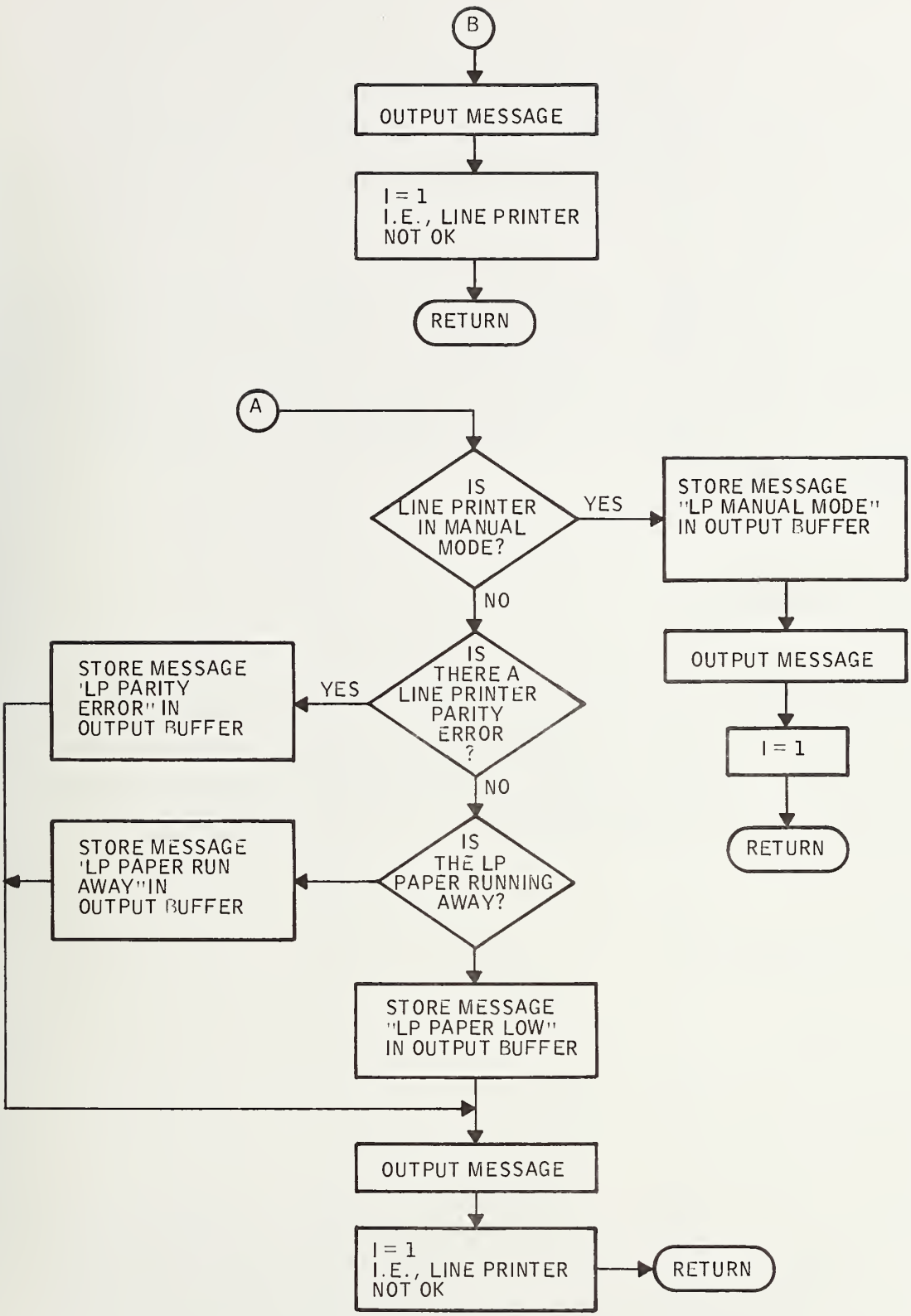
If an error condition exists, an appropriate message is printed on the teletype.

2.6.29.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine TSTLP



Subroutine TSTLP (Concluded)

2.6.30 ROUTINE I

2.6.30.1 Purpose

At the end of each 24-hour period or when the system is set into shutdown, Routine I produces a hard copy report which is a summary of the UTCS part of the system (Figure 9). This report contains a link by link summary of all measures of effectiveness as well as section and overall system measures of effectiveness.

2.6.30.2 Relationship

This routine is entered once per 24-hour period or at any time the shutdown procedure is called. The routine is called at Level 3. It schedules Routine Q, when required. Routine I is subdivided into the following subroutines: CAL15, CALRL, DECON, EISRT, SBYTC, STMSG, TIMEH, and TSTLP. Each of these is called by Routine I.

2.6.30.3 Assumption

None.

2.6.30.4 Approach

Upon entry Routine I begins processing the links in increasing numerical order. For each link that has detectors associated with it, it prints out accumulated daily volume (VDAY), accumulated daily percent occupancy (OPC = ODAY/NRPRT), accumulated daily speed (ASVP = SDAY/NRPRT), accumulated daily travel time (TTTMP = D* VDAY/5280* AVSP). If the

END OF DAY REPORT

DATE MAR 25 76 TIME 2215

INITIAL TIME 2000 REPORT NO. 1

	LINK	VOLUME VEHICLES	TRAV.TIME VEH-HRS	DELAY HRS	STOPS VEH	OCCUPANCY PERCENT	QUEUE VEH/CYCLE	SPEED MPH
SECTION 1	1	1177	3.8			19.5		14.0
	2	617	1.7			3.0		27.1
	3	550	2.0			14.5		16.6
	4	707	2.0			5.3		19.3
	5	496	.8			4.0		24.0
	6	314	.0			5.8		.0
	7	739	1.8			6.3		23.4
	8	602	1.5			7.0		15.3
	9	0	.0			.0		.0
	10	1041	5.0			25.5		12.4
	11	913	4.8			17.8		13.5
	12	1095	5.0			10.3		17.2
	13	740	.0			5.8		.0
	15	1005	3.0			6.8		20.9
	16	824	2.3			5.3		18.3
	17	297	.0			1.8		19.3
	18	595	1.0			3.3		24.3
	20	469	1.3			2.5		23.8
	21	239	.0			1.5		18.7
	22	0	.0			.0		.0
	24	512	2.0			9.3		18.1
	25	0	.0			.0		.0
	26	725	2.3			5.3		21.3
	27	184	.3			.5		21.5
	34	833	1.3			10.5		15.0
	139	1114	3.3			9.5		17.9
	145	769	2.8			7.5		17.1
	149	474	2.0			5.0		18.7
TOTAL		16544	51.0					
AVERAGE			1.3			6.8		16.8
SECTION 2	19	494	2.0			3.0		27.7
	20	367	1.3			2.3		30.7
	21	1	.0			.0		.0
	23	96	.0			5.8		24.7
	24	721	3.5			5.5		20.8
	25	0	.0			.0		.0
	26	184	.8			.8		21.5
	27	773	2.0			24.3		22.3
	28	209	.8			1.3		23.9
	29	0	.0			.0		.0
	30	0	.0			.0		.0
	31	124	.0			.3		29.0
	32	484	1.0			2.0		31.2
	33	454	.8			2.5		20.4
	34	431	.8			1.3		33.9
	35	311	.8			12.8		14.4
	36	677	1.7			3.3		26.7
	37	170	.7			.8		23.7
	38	1109	3.3			6.8		21.7
	39	282	.8			2.5		25.6
	40	1044	1.5			5.5		25.7
	41	199	.8			1.0		22.4
	42	1024	1.5			5.8		23.9
	43	858	1.2			4.5		24.8
	44	976	1.5			5.5		24.0
	45	409	.5			2.0		22.4
	46	858	1.3			4.5		24.7
	47	996	1.5			5.0		23.7
	48	130	.0			.5		23.4
	49	864	1.3			4.3		27.4
TOTAL		14700	25.5					
AVERAGE			.8			3.8		21.3
SECTION 3	52	324	.5			1.3		27.3
	58	569	.8			10.0		19.4
	59	299	.0			6.8		14.5
	60	374	.8			3.0		22.3
	61	237	.5			3.3		19.8
	62	684	1.5			3.0		24.7
	63	435	1.5			4.5		17.8
	64	146	.3			1.0		20.3
	65	599	1.5			3.3		25.8
	66	274	.5			1.8		25.5
	67	674	3.0			19.3		22.2
	68	729	2.3			5.0		22.9
	69	592	1.5			3.8		22.0
	70	506	1.3			3.0		23.0
	72	432	1.5			2.8		28.2
	73	493	.5			2.0		27.3
	74	869	2.0			13.0		16.6
	75	654	1.5			2.8		27.9
	76	0	.0			.0		.0
	77	600	1.5			2.8		25.1

Figure 9. UTCS System Summary, End-of-Day Report

END OF DAY REPORT

DATE MAR 25 76 TIME 2215

INITIAL TIME 2000 REPORT NO. 1

LINK	VOLUME VEHICLES	TRAV.TIME VEH-HRS	DELAY HRS	STOPS VEH	OCCUPANCY PERCENT	QUEUE VEH/CYCLE	SPEED MPH
78	456	.8			5.3		21.1
79	451	1.0			2.5		23.8
80	544	1.3			2.5		26.2
81	485	1.0			2.5		23.8
82	468	1.0			2.5		22.6
83	432	1.0			5.0		21.6
85	391	.6			1.8		25.1
86	245	1.0			2.8		15.0
87	149	.3			1.3		19.2
88	258	.8			2.8		25.0
89	466	1.0			3.8		23.0
90	433	.8			2.3		21.7
91	281	.8			1.0		28.2
92	451	.8			4.8		18.7
93	334	.8			1.3		29.8
95	474	1.0			2.0		23.3
96	354	1.0			6.0		19.5
98	472	2.8			5.8		22.6
99	506	.8			2.8		21.8
100	85	.3			.5		20.3
102	47	.3			.3		17.1
104	682	2.0			3.5		24.0
105	434	1.3			5.3		18.6
106	625	3.0			11.5		14.5
107	781	1.0			10.5		17.4
108	576	1.8			3.0		27.7
109	430	1.0			1.8		26.4
110	688	2.8			18.0		15.3
111	492	1.0			3.0		26.6
112	564	.0			8.3		.0
113	251	.6			1.0		23.6
114	499	1.3			2.3		24.7
116	500	1.0			3.0		20.9
117	504	3.0			5.8		21.2
120	518	1.3			4.5		20.9
121	174	.3			1.8		20.6
122	469	1.0			4.8		20.3
123	574	1.8			5.0		23.7
124	387	1.3			2.3		22.3
125	1038	4.3			10.5		16.9
126	50	.0			.5		17.5
127	0	.0			.0		.0
128	363	1.0			2.3		20.6
129	477	1.5			3.5		19.7
130	710	2.8			4.3		22.2
131	169	.3			3.5		22.1
132	437	2.3			5.3		19.2
133	350	1.3			2.3		21.2
134	64	.0			.3		21.2
135	493	2.0			18.5		12.5
136	374	.0			2.5		.0
137	738	2.3			5.3		20.8
138	297	1.0			12.5		19.1
139	651	2.8			4.3		21.0
140	410	1.5			4.0		23.4
141	400	1.8			4.0		19.4
142	421	1.0			2.0		23.5
143	825	3.8			8.5		18.1
144	125	.5			2.0		18.8
146	459	1.8			5.3		20.5
147	1104	4.8			13.8		15.3
148	523	1.8			4.8		19.4
150	504	1.3			2.8		23.0
151	438	1.5			4.0		25.3
152	113	.3			3.5		20.0
153	809	2.0			6.5		19.0
154	587	1.5			4.0		23.6
155	191	.5			1.3		19.4
156	0	.0			.0		.0
157	799	2.3			13.3		18.9
158	576	1.5			3.0		22.7
159	481	1.3			4.3		17.8
160	540	1.8			4.8		22.5
161	452	1.0			5.8		21.1
162	458	.5			3.3		20.6
163	582	1.5			3.8		19.4
164	589	1.8			3.5		22.4
165	263	.8			2.3		20.2
166	189	.8			1.0		24.6
167	403	1.0			2.5		21.4
168	385	1.3			3.3		16.6
169	659	1.8			4.8		20.8
170	836	1.3			12.0		26.1
171	405	.8			2.3		22.8
172	0	.0			.0		.0
173	111	.3			1.0		19.8
174	564	.0			16.5		.0
175	588	1.0			3.8		20.2

Figure 9. UTCS System Summary, End-of-Day Report (Continued)

END OF DAY REPORT

DATE MAR 25 76 TIME 2215

INITIAL TIME 2000 REPORT NO. 1

	LINK	VOLUME VEHICLES	TRAV.TIME VEH-HRS	DELAY HRS	STOPS VEH	OCCUPANCY PERCENT	QUEUE VEH/CYCLE	SPEED MPH
	176	294	.5			2.0		21.1
	177	705	2.0			7.3		18.9
	178	119	.0			.8		21.2
	179	654	2.0			4.5		21.2
	180	767	2.3			11.8		16.1
	181	542	2.3			4.8		18.6
	182	77	.3			.3		19.0
	183	924	2.2			8.5		18.9
	184	745	1.8			9.8		16.1
	185	396	1.5			12.3		17.1
	186	325	.8			1.5		23.2
	187	1328	3.3			10.0		18.3
	188	320	1.3			12.0		13.0
	189	479	2.0			29.5		14.2
	190	809	3.0			13.5		14.2
	191	426	1.0			2.3		23.1
	192	595	.0			12.8		.0
	193	544	1.0			4.3		19.3
	194	561	1.5			4.3		19.5
TOTAL		62812	161.8					
AVERAGE			1.3			4.8		20.3
SECTION 4	195	422	.5			2.5		23.2
	196	673	1.3			6.0		19.9
	197	265	.5			.8		31.2
	198	309	.5			1.0		30.0
	199	795	1.5			2.8		35.4
	200	464	.3			7.0		20.9
	201	466	1.0			2.8		29.0
	202	337	.5			1.5		24.1
	203	129	.0			.5		25.8
	204	187	.5			.5		28.6
	205	0	.0			.0		.0
	206	317	.8			1.0		31.6
	207	403	1.0			1.8		27.3
	208	302	.8			.8		38.9
	209	302	.8			2.0		21.6
	210	0	.0			.0		.0
	211	360	1.3			2.0		21.0
	212	478	1.3			2.3		25.8
	213	830	2.0			3.5		30.5
	214	501	.0			3.5		.0
	215	414	1.0			1.8		27.7
	216	415	1.3			2.3		22.5
	217	460	1.0			1.8		29.2
	218	762	2.0			9.0		24.4
	219	339	.8			1.8		22.7
	220	287	.5			1.3		25.8
	221	204	.3			1.5		16.9
	222	293	.3			2.3		16.8
	223	550	1.5			2.8		23.8
	224	412	.3			1.5		25.1
	225	700	3.3			4.0		22.9
	226	0	.0			.0		.0
	227	451	1.3			2.0		26.6
	228	236	.3			1.8		17.4
	229	121	.3			.8		19.0
	230	124	.3			.5		22.5
	231	164	.3			.5		27.8
	232	201	.5			1.3		23.6
	233	69	.2			.3		18.2
	234	217	.5			.8		24.4
	235	357	.3			2.5		21.5
	236	256	.8			1.8		19.3
	237	227	.5			.8		26.7
	238	512	1.0			3.5		24.7
	239	541	.8			4.3		23.0
	240	64	.0			.3		22.0
	241	254	.3			1.3		25.9
	242	694	1.5			4.8		20.8
	243	127	.5			.8		19.6
	244	487	1.0			2.8		24.0
	245	795	1.8			6.0		19.8
	246	504	1.3			3.3		25.1
	247	0	.0			.0		.0
	248	716	.0			10.3		.0
	249	41	.0			.0		27.1
	250	375	.5			2.3		20.4
	251	582	1.3			4.8		19.3
	252	360	1.0			2.0		21.8
	253	53	.0			1.3		23.3
	254	137	.3			6.5		26.3
	255	0	.0			.0		.0

Figure 9. System Summary, End-of-Day Report (Continued)

END OF DAY REPORT

DATE MAR 25 76 TIME 2215

INITIAL TIME 2000 REPORT NO. 1

	LINK	VOLUME VEHICLES	TRAV.TIME VEH-HRS	DELAY HRS	STOPS VEH	OCCUPANCY PERCENT	QUEUE VEH/CYCLE	SPEED MPH
TOTAL		20917	41.8					
AVERAGE			.7			2.3		22.2

SYSTEM PERFORMANCE	VOLUME TOTAL	TRAV.TIME TOTAL	DELAY TOTAL	STOPS TOTAL	OCCUPANCY PERCENT	QUEUE AVERAGE	SPEED AVERAGE
	114972	280.0			4.3		20.6

Figure 9. UTCS System Summary, End-of-Day Report (Concluded)

controller associated with a link is not on line and the link has at least one failed detector, speed (AVSP) and travel time (TTTMP) are set to zero.

For each section, totals are printed out for volume (VSECT) and travel time (TTSCT/NLSPT). Averages are printed out for occupancy (OSECT/NLS) and speed (SSECT/NLSPT).

After all the links and sections summaries are printed out, system performance is printed. This report contains volume (VSUM), travel time (TTSUM), average occupancy (OSUM/NLSS), and average speed (SSUM/NLSPS).

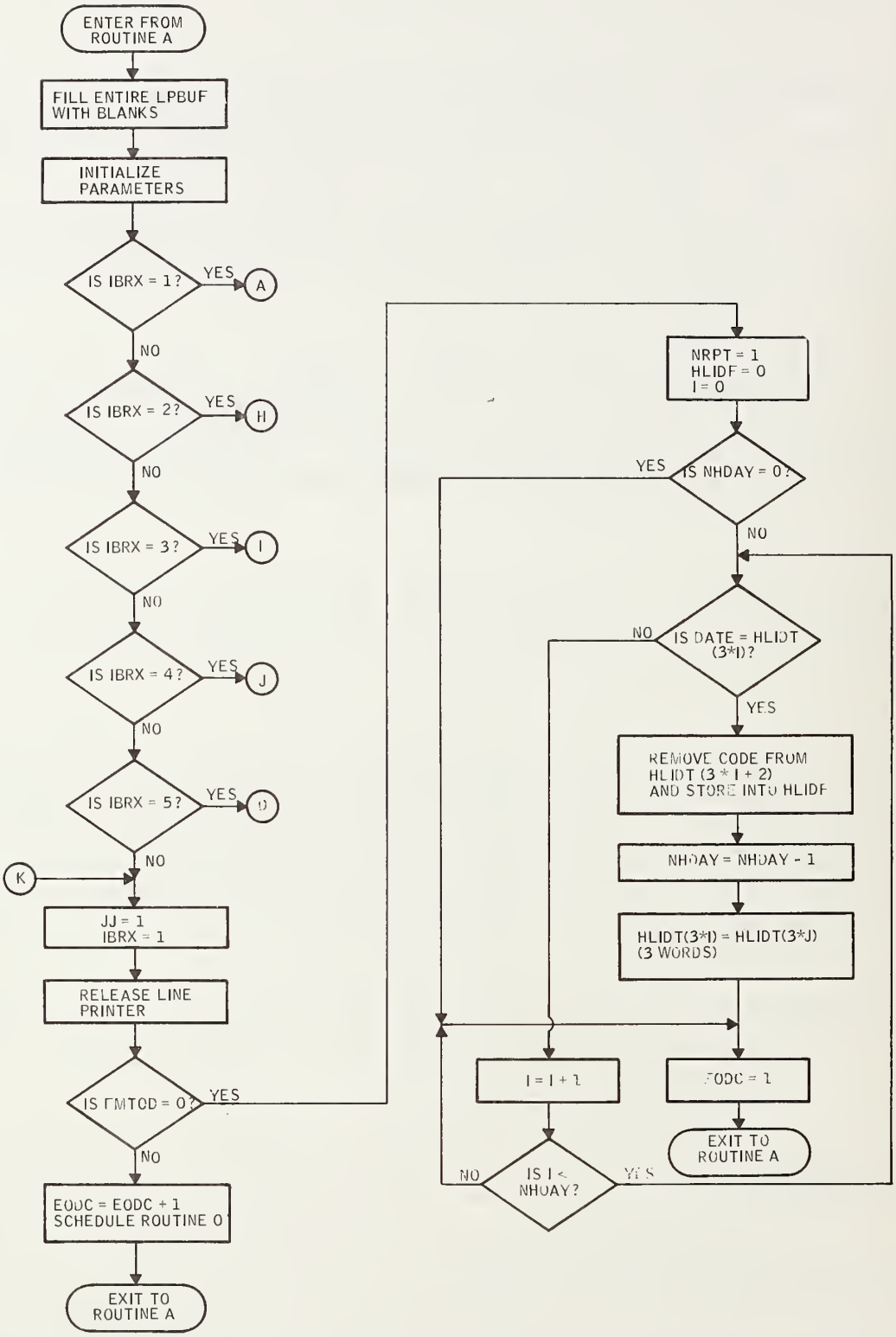
Routine I then initializes to zero the accumulated daily volume (VDAY), accumulated daily occupancy (ODAY), and the accumulated daily speed (SDAY).

Routine I checks to see if it is midnight (FMTOD = 0). If it is not, the end of day count (EODC) is incremented and Routine Q (SHUTDOWN) is scheduled. Routine I then exits. If it is midnight, the holiday flag (HLIDF) is set: 0 — no holiday, 1 — Saturday type holiday, 2 — Sunday type holiday. The end of day count (EODC) is reset to 1. Routine I then exits.

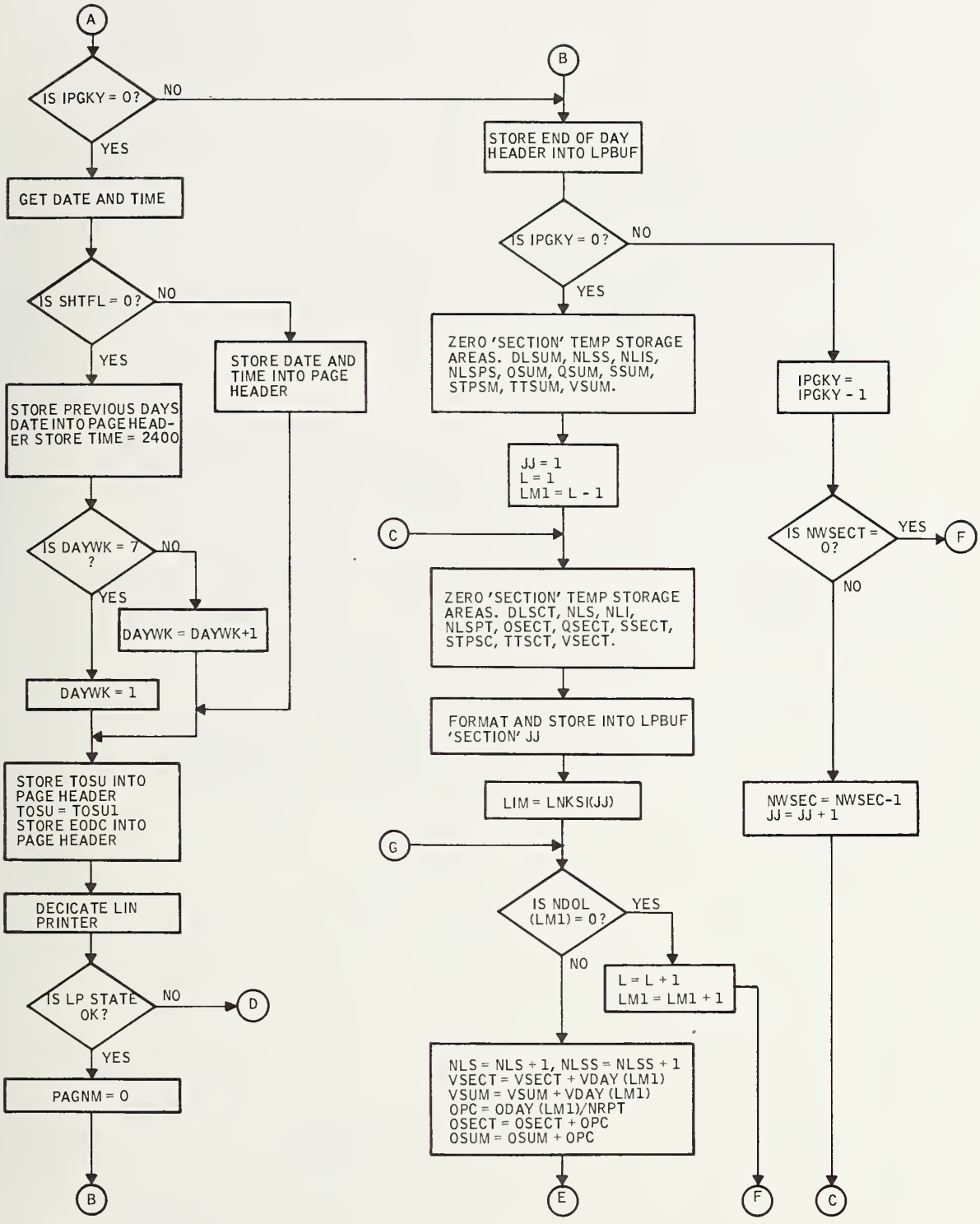
All of the BPS End-of-Day report generation has been deleted from Routine I.

2.6.30.5 Listing

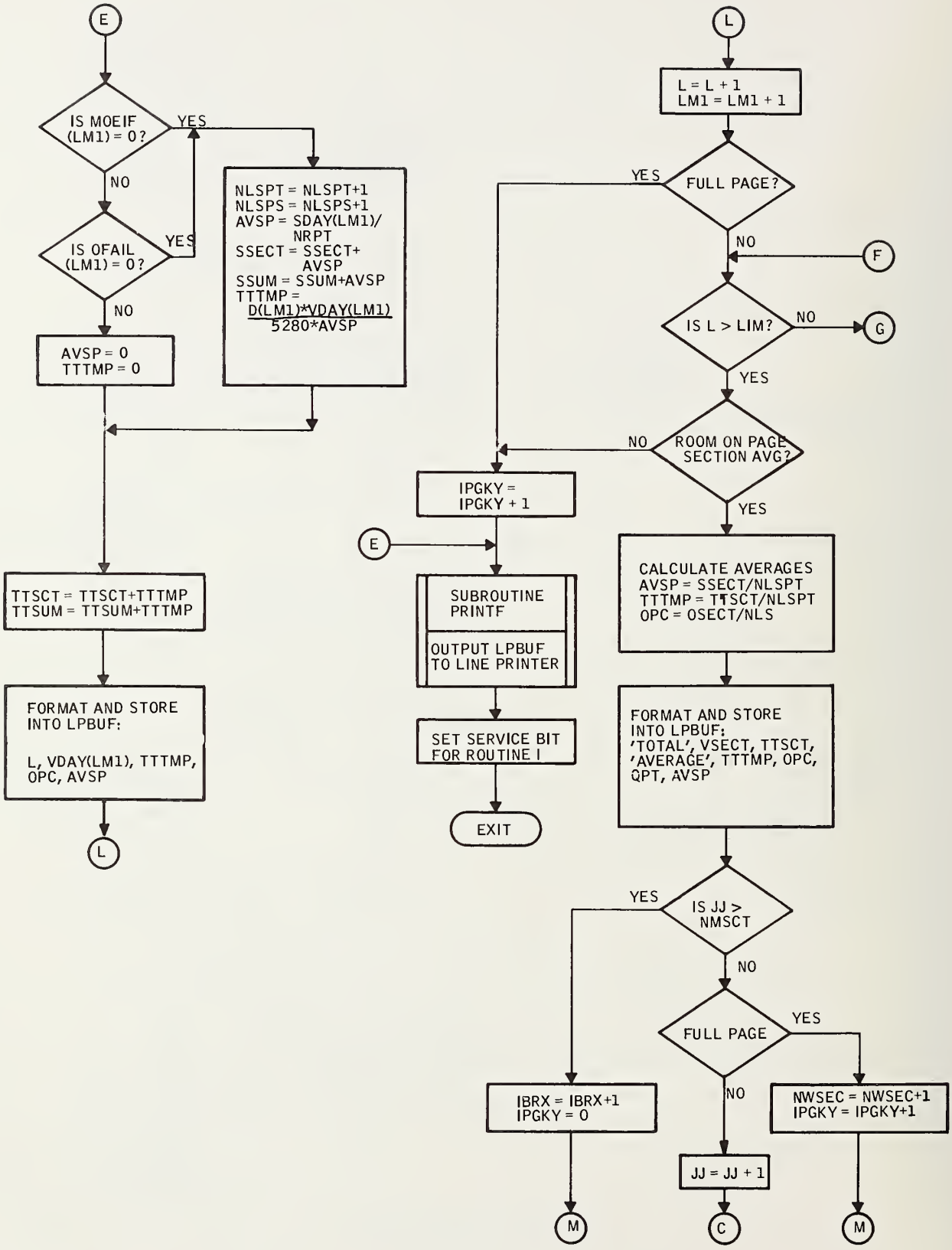
See Volume III, 2GCF Routine Listings.


ENTER FROM ROUTINE A
FILL ENTIRE LPBUF WITH BLANKS
INITIALIZE PARAMETERS
IS IBRX = 1?
YES
A
NO
IS IBRX = 2?
YES
H
NO
IS IBRX = 3?
YES
I
NO
IS IBRX = 4?
YES
J
NO
IS IBRX = 5?
YES
D
NO
K
JJ = 1
IBRX = 1
RELEASE LINE PRINTER
IS FMTOD = 0?
YES
NO
EODC = EODC + 1
SCHEDULE ROUTINE 0
EXIT TO ROUTINE A
NRPT = 1
HLIDF = 0
I = 0
YES
IS NHDAY = 0?
NO
NO
IS DATE = HLIDT (3*I)?
YES
REMOVE CODE FROM HLIDT (3 * I + 2) AND STORE INTO HLIDF
NHDAY = NHDAY - 1
HLIDT(3*I) = HLIDT(3*J) (3 WORDS)
I = I + 1
EODC = 1
EXIT TO ROUTINE A
NO
IS I < NHDAY?
YES

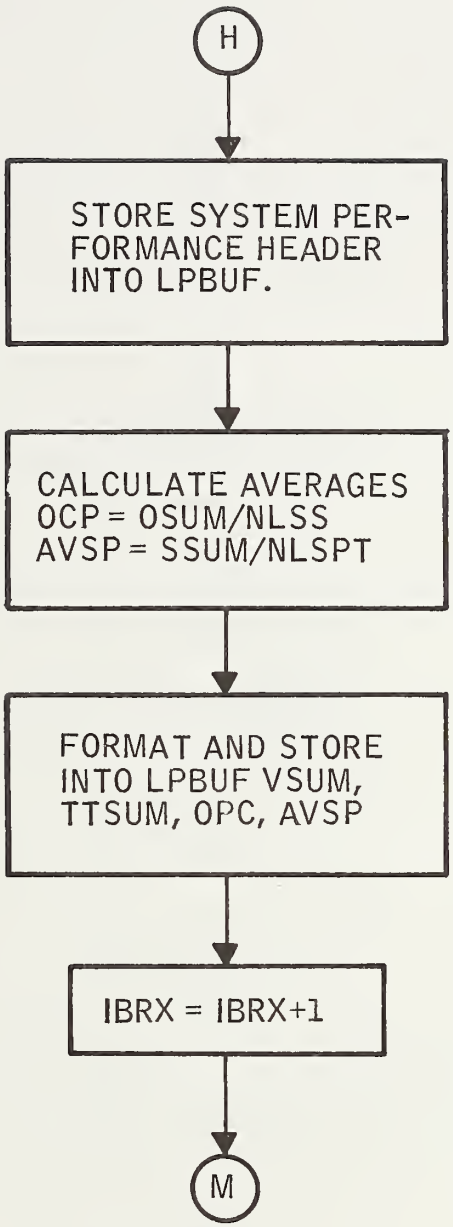
Routine I



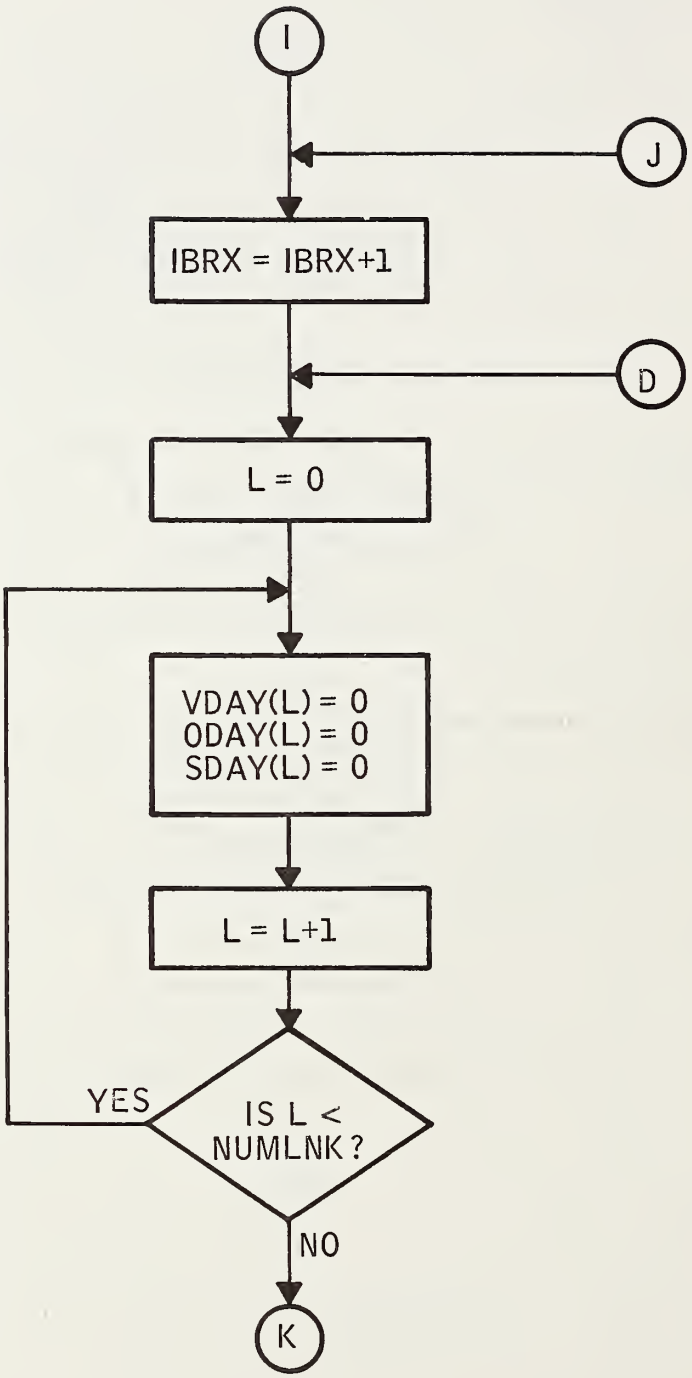
Routine I (Continued)



Routine I (Continued)



Routine I (Continued)



Routine I (Concluded)

2.6.31 SUBROUTINE PRPRED

2.6.31.1 Purpose

This subroutine summarizes and prints predictor performance at shutdown or at end of day report.

2.6.31.2 Relationship

PRPRED is called from Routine PREDICT by:

```
CALL PRPRED
```

It uses subroutine STMSG to place data in the output buffer.

2.6.31.3 Assumption

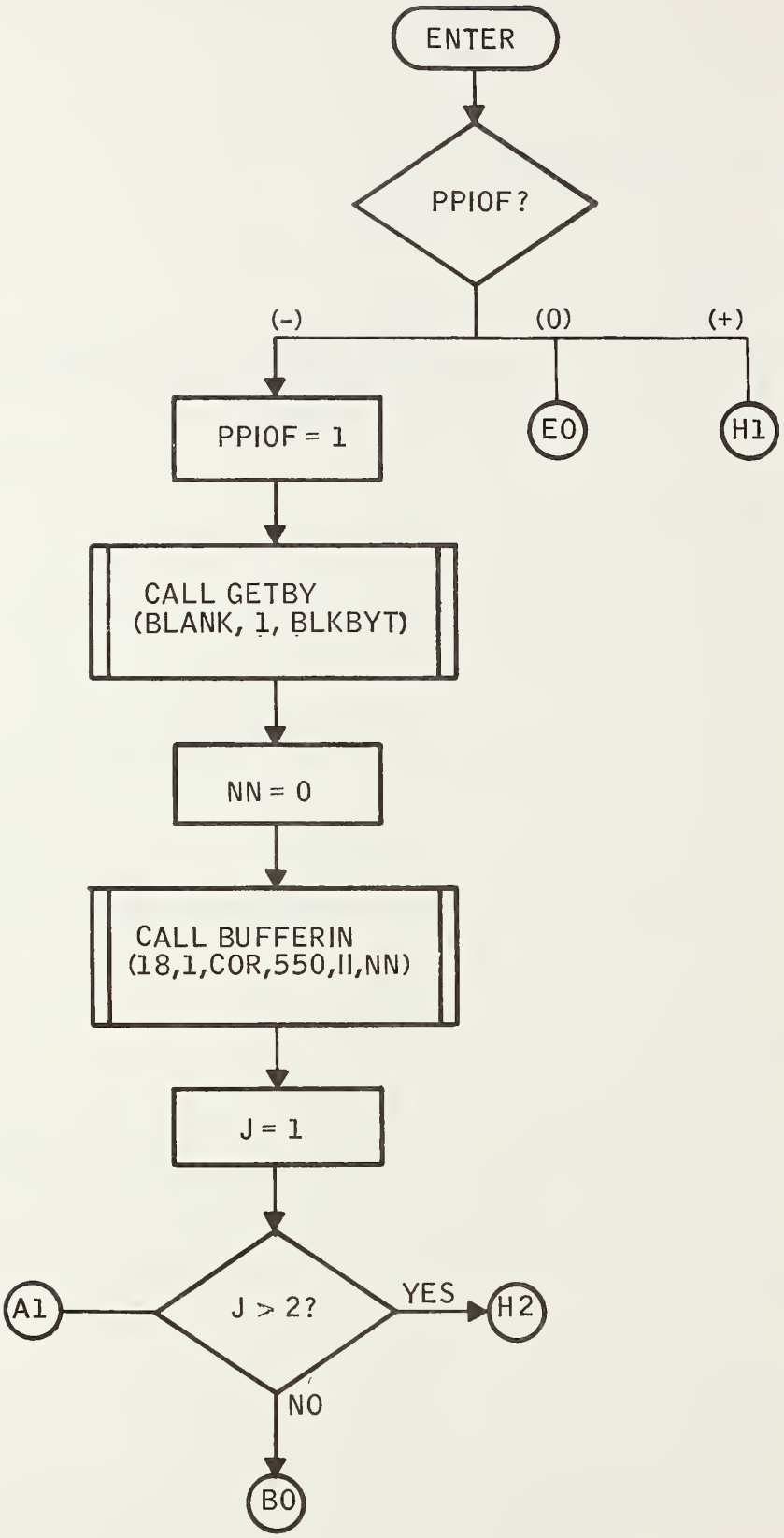
The cumulative statistics are available from file 15, 16, and 17.

2.6.31.4 Approach

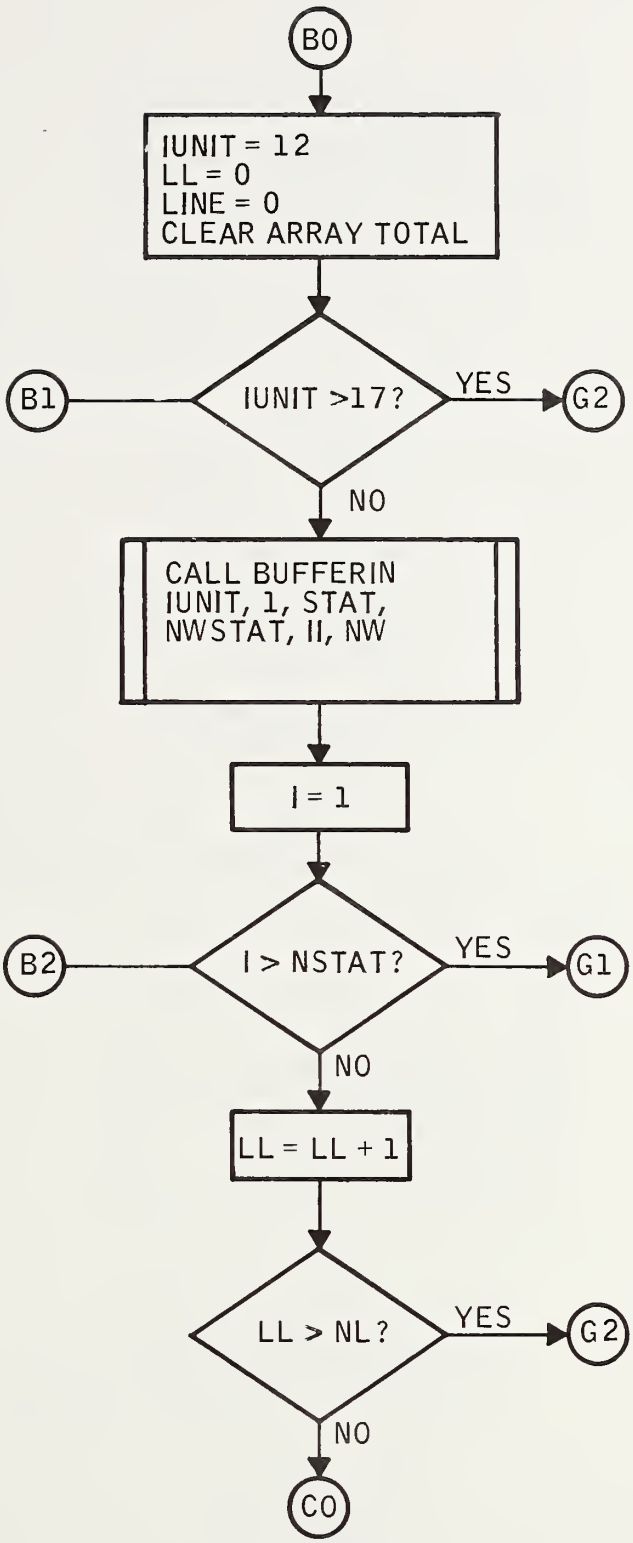
The cumulative statistics are extracted from files 15, 16, and 17. Then mean error, standard deviation of errors, mean relative error, standard deviation of relative error, RMS relative error, mean absolute relative error (AM1) and the proportion of times that AM1 $> .05$, $\geq .10$, $\geq .20$ are computed for each link.

2.6.31.5 Listing

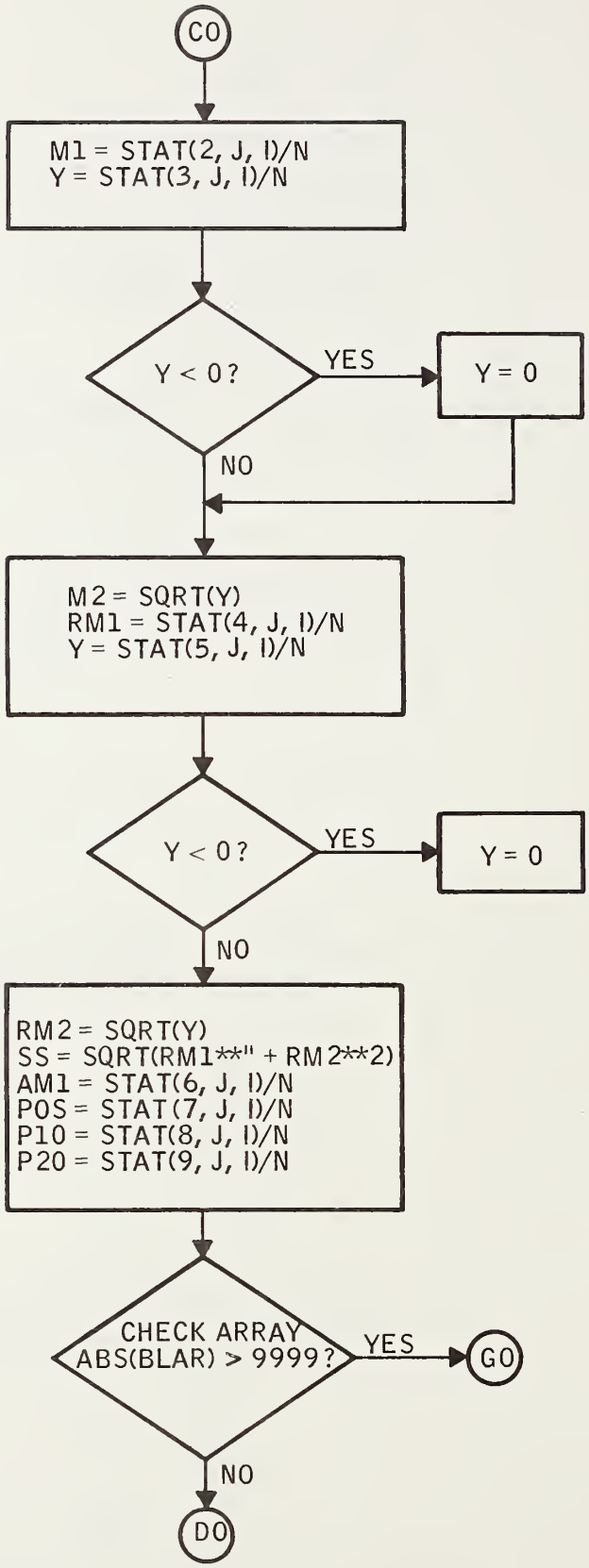
See Volume III, 2GCF Routine Listings.



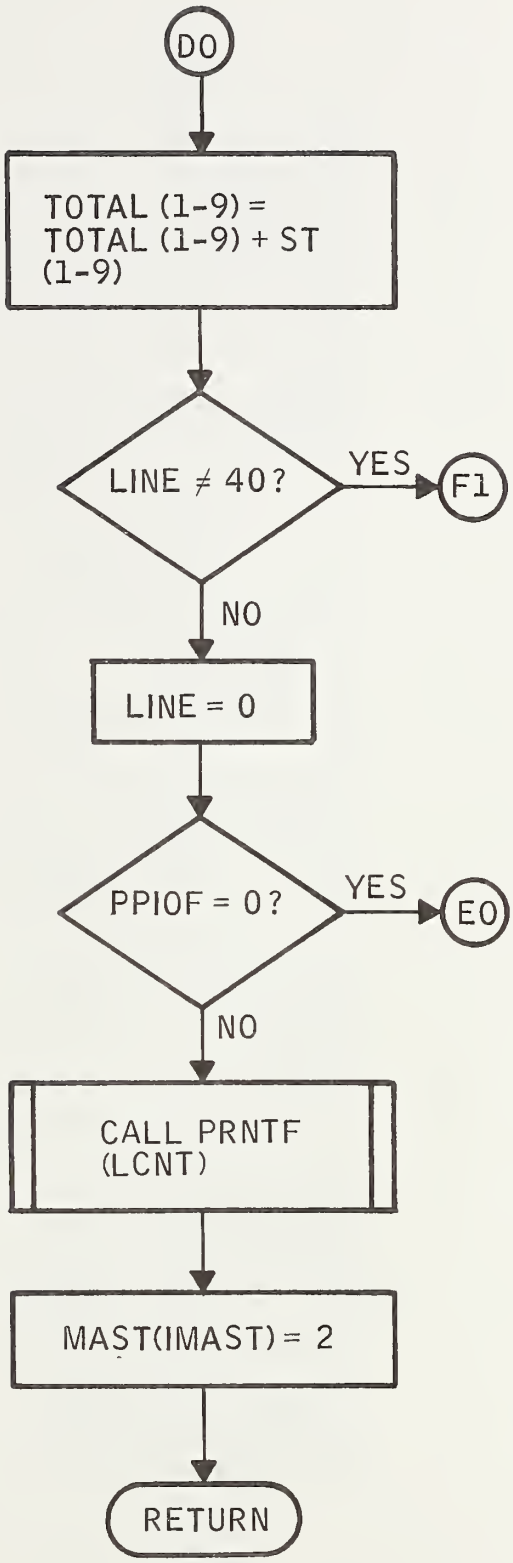
Subroutine PRPRED



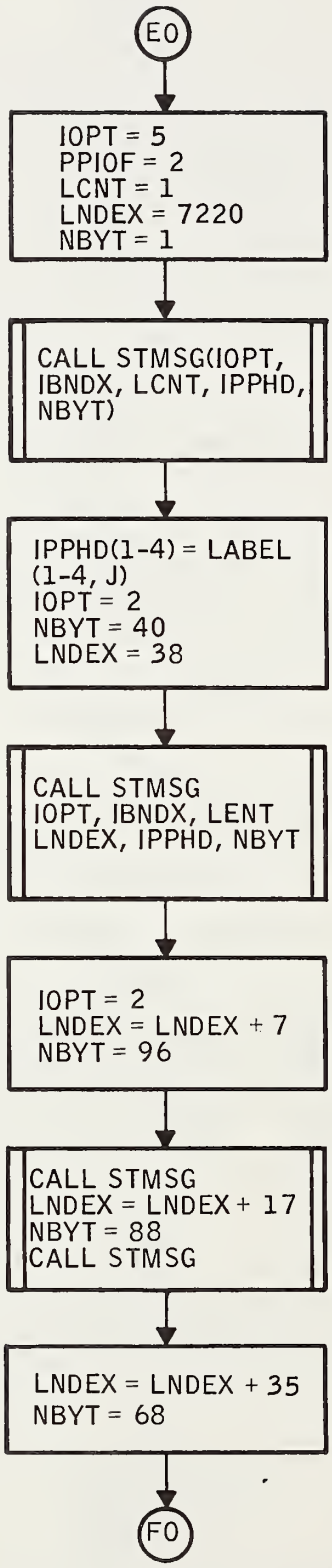
Subroutine PRPRED (Continued)



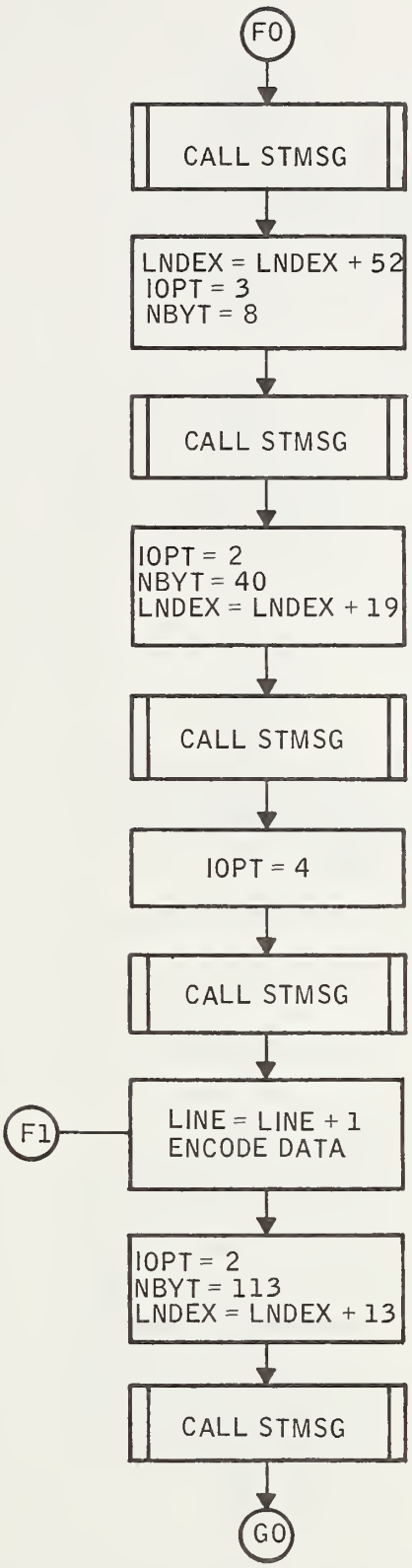
Subroutine PRPRED (Continued)



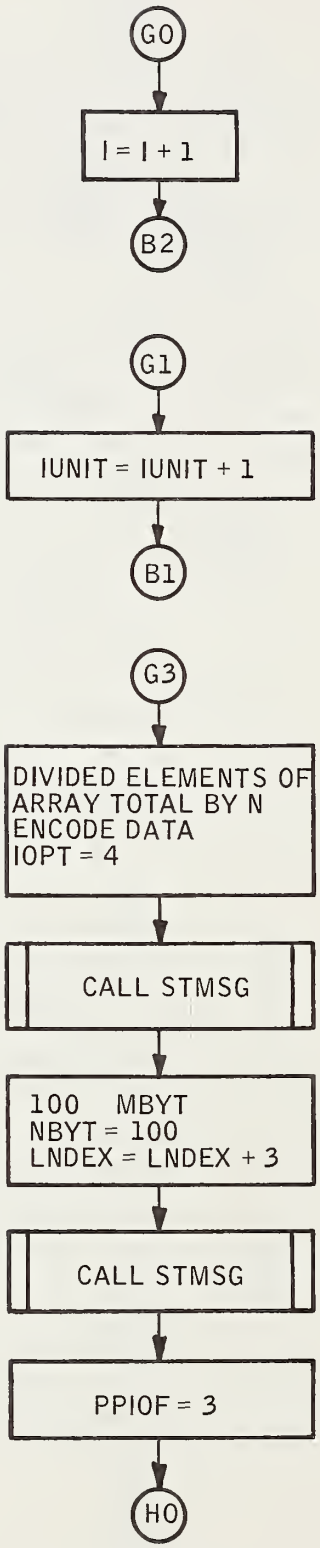
Subroutine PRPRED (Continued)



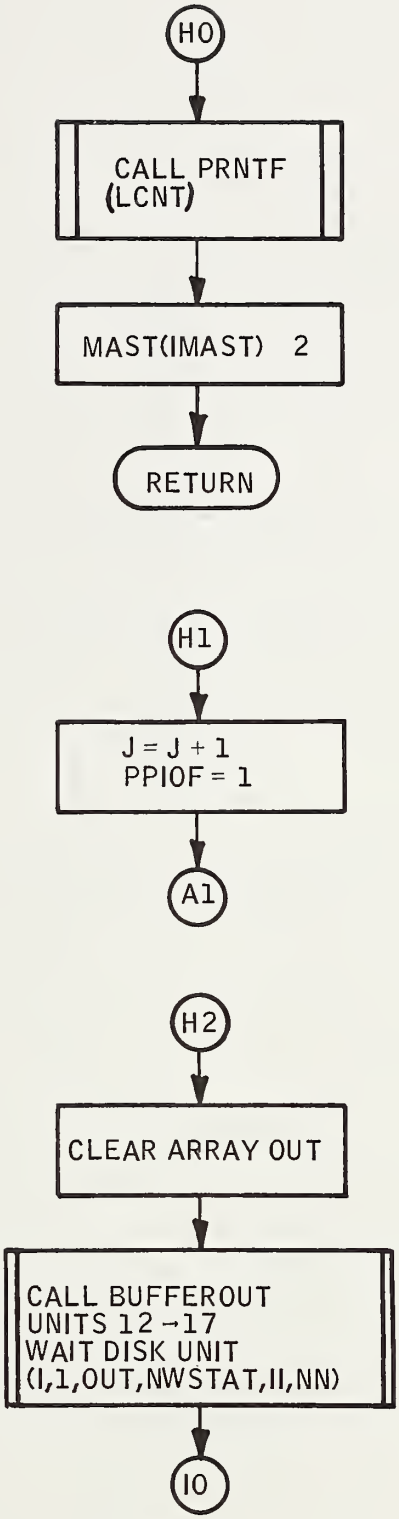
Subroutine PRPRED (Continued)



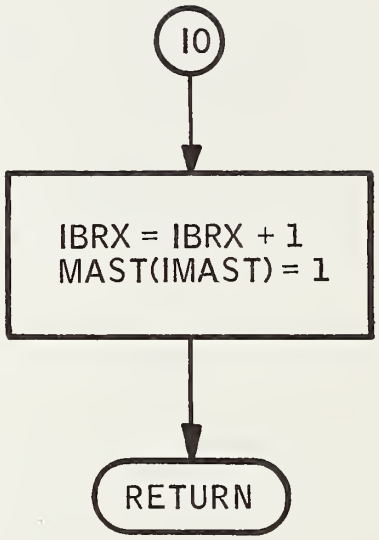
Subroutine PRPRED (Continued)



Subroutine PRPRED (Continued)



Subroutine PRPRED (Continued)



Subroutine PRPRED (Concluded)

2.6.32 ROUTINE J

2.6.32.1 Purpose

The Map Control and Data Formatting Routine controls the indicator arrows at the illuminated street map display. The indicator arrows are of two types, those providing controller status information, and those providing data on link parameters, including detector status information.

The Map Display consists of two separate displays. The Controller Display comprises the intersection arrows which are illuminated in green or red. The Surveillance Display comprises the link arrows which parallel their corresponding streets and which are illuminated in orange. A third display, the Legend Display, identifies the display modes and indicates any flow data threshold being used.

The 397 Map Display control signals in the original 114 intersection system are included among the 32 per second MUX inputs and outputs. Each map output word, which is sent to the MUX along with a MUX format word, contains one nine-bit address and two signal state bits. Output words containing map switches and display controls (i.e., the 24 legend on/off switches, the 16 bits comprising the four BCD threshold digits, the enable/disable communication discrete, and the enable/disable traffic signal lamps switch) use only one of the two state bits. Most of those containing intersection of link arrow lamp controls use both state bits. However, some intersection state bits refer to non-existent controllers in order to maintain a consecutive numbering scheme: only 114 of the 124 intersection state bits provided in the 62 output words are used. On the other hand, all but one of the 254 state bits in the 127 link arrow output words are used.

Routine J inserts the appropriate state bits in the Map Signal Output Array for the requested Controller and Surveillance Displays. Every 1/32 of a second, the Executive Routine A transmits 24 state bits and associated addresses (12 data words) to the map. (The 24 per 1/32 of a second limitation is due to the 2 signals per millisecond rate at which the map decoding logic can accept signal data.) The Map Signal Output Array (LMAP) comprises 35 x 12 = 420 data words, thus providing the capacity for 840 outputs. The entire array is output every 35/32 seconds.

The one-way arrows on 15th and 17th streets are operated directly by District of Columbia Department of Transportation (DCDOT) radio signals and are independent of Routine J.

In addition to the nine-bit address and the two signal state bits, each data word transmitted to the map contains a one-bit strobe signal. The value of this strobe signal is "1" for the odd-numbered sequential data words (i.e., first, third, ...) in each 12-word group transmitted during a 1/32 of a second time slot, and "0" for the even-numbered data words (i.e., second, fourth,...). Thus, whenever a new word is transmitted, the strobe signal state changes. This state change informs the map decoding logic that a new word is ready to be processed.

In processing a data word, the map decoding logic operates on the nine-bit address to determine the destination of the two state bits. It then routes the state bits to their respective switches or lamps and waits for the next data word.

If the nine-bit address is invalid (i.e., it does not reference an existing signal or signal pair), it will be ignored by the decoding logic. If the address refers to one signal, rather than to a signal pair, the decoding logic will route the leftmost state bit in the data word to that signal.

2.6.32.2 Relationship

This routine is entered whenever there is an operator request and at 6-second intervals for updating data. The routine is scheduled by Routine A and returns to that routine. The routine is divided into the following subroutines: BCDTH, CDL, CLS, SDL, STLNK, and TCSLP. These subroutines are called by Routine J.

2.6.32.3 Assumption

A-phase green displays are directly controlled by hardware.

2.6.32.4 Approach

The status of the A-Phase at each controlled intersection, whether red or green, is transmitted directly to the map and is always available even when the computer is not in operation. It will be displayed at all times except when deliberately turned off or when Controller Status or Controller Failed displays are requested.

Controller Status can be requested in two modes: Traffic Control, and CIC. In the Traffic Control mode, green arrows are displayed at all intersections under computer control, red arrows for those in standby. In the CIC mode, green arrows are displayed for the intersections which have been activated for Critical Intersection Control, red for all others.

Controllers Failed are called for in the Traffic Control mode only. Here all intersections where the controllers have failed display red arrows, all others green arrows.

Surveillance Equipment Failed is called for in the Traffic Control mode. In this mode, any link having a vehicle detector or communication failure will be illuminated in orange.

Link flow data is selected by type and threshold value. For the Traffic Control mode, the following types of flow data (MOE) can be selected:

- Occupancy
- Volume
- Speed.

In any case, only those links are illuminated where the MOE value exceeds the selected threshold for occupancy or volume, or where the speed value is less than the selected threshold.

The Executive Routine (A) schedules Routine J every 6 seconds for a periodic updating of the Controller and Surveillance Displays. Routine J is also scheduled by the Manual Control Panel Routine (M) whenever the operator enters a valid Map Display request. Note that up to 35/32 seconds may pass until all map switches and lamps are set to the states included in the updated Map Signal Output Array.

Upon entry, Routine J first examines the Controller Display Code to determine which Controller Display mode is to be presented (0 for A-Phase green; 1 for Controllers Off; 2 for Controllers Status, 3 for Controllers Failed; 4 for CIC status). It then branches to the appropriate program segment to format the applicable Legend Display; to set the enable/disable lamp switches as required; and to determine the red/green state for each intersection arrow lamp according to the selected Controller Display mode. After preparing the Controller Display, Routine J examines the Surveillance Display Code (0 for Surveillance Display Off; 1 for Traffic Control System

Equipment Failed; 2 for Flow Data). It branches to the appropriate program segment to format the applicable Legend Display and to determine the on/off state for each link arrow lamp according to the selected Surveillance Display Mode. Note that the Controller and Surveillance Display Codes remain intact until the operator requests a mode change using the Control Panel.

Routine J enters the signal states for the Controller Display and for the Legend Display directly in the Map Signal Output Array. However, to avoid momentary "blackouts" of the Surveillance Display due to the fact that J turns off all link arrows prior to determining their on/off states, the routine first generates the Surveillance Display in a temporary buffer and then moves that array into the Map Signal Output Array.

When Routine J completes the updating of both the Controller Display and the Surveillance Display, it returns control to the calling routine. During the next 35/32 seconds all the updated switch and lamp states will be output to the map.

The following paragraphs describe two utility subroutines employed in preparing Flow Data Surveillance Displays and data arrays upon which Routine J operates.

Subroutine TCSLP (PAR, MTHLD, B, F, S) -- The utility subroutine TCSLP compares a Traffic Control System parameter value for each link with a threshold value, MTHLD. The link parameters are stored in a halfword (S = 0) or byte (S = 1) array starting at location PAR. If the flag F is zero, a link arrow is illuminated if and only if the corresponding link parameter exceeds the threshold value. If F is non-zero, the arrow is illuminated if and only if the parameter is less than the threshold.

TCSLP uses Subroutine BCDTH to format MTHLD for BCD presentation in the Legend Display.

Subroutine BCDTH Description -- The utility Subroutine BCDTH converts the positive binary integer MTHLR (≤ 9999) to BCD and stores the resulting bit configuration in the Map Signal Output Array. The binary representations of BCD digits are:

	8-Bit	4-Bit	2-Bit	1-Bit
0 =	0	0	0	0
1 =	0	0	0	1
2 =	0	0	1	0
3 =	0	0	1	1
4 =	0	1	0	0
5 =	0	1	0	1
6 =	0	1	1	0
7 =	0	1	1	1
8 =	1	0	0	0
9 =	1	0	0	1

Map Signal Output Array (LMAP) -- The Map Signal Output Array organization comprises 840 words: 420 MUX "order" words interleaved with 420 data words. All 420 MUX order words are identical: Each order word, when presented to the MUX, causes bytes 0, 1, and 2 of the following data word to be transmitted to the three 7950 stored output modules connected to the map; it then causes a 1 millisecond delay before the next order word is accepted by the MUX.

Each map data word has the following format:

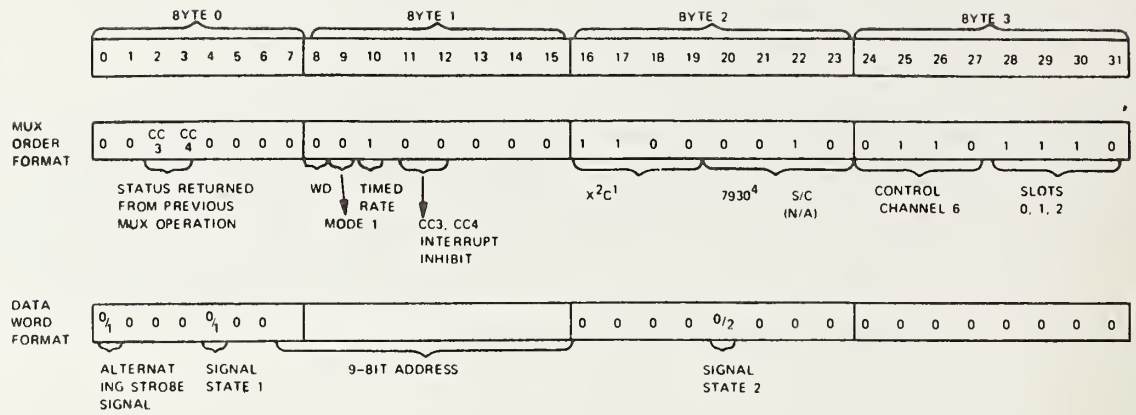
- Bit 0 (sign bit) is the alternating strobe signal discussed in Section 1.
- Bits 4 and 20 are the two signal state bits.
- Bits 7 through 15 are the 9-bit signal pair address.

The strobe signal (bit 0) and the 9-bit address (bits 7 - 15) in each data word are set to their appropriate values when the program is loaded into the computer and do not change. The state bits are inserted (using the logical operation instructions of the computer) by Routine J as a function of the display being presented.

In the Map Signal Output Array organization (Figure 10) the first 48 data words contain a signal status (one per data word) for the map controls and Legend Display; however, only 32 of these data words are used in the present system. The next 116 data words contain the green/red intersection arrow status (two per data word) of the Controller Display; the present system uses 62 words, providing 124 state bits. The next 256 data words contain the on/off link arrow states (two per data word) of the Surveillance Display; 127 of these are used in the present system, providing 254 state bits.

The following algorithms can be used to reference state bits in the LMAP array. These algorithms compute the byte address, relative to the first byte of the array, of the byte containing the signal state. The signal state itself is in bit position 4 of the byte (i.e., the fifth bit from the left end of the byte).

- The Enable/Inhibit Communications control bit is in byte 4 of the array.
- The Enable/Disable Traffic Signals control bit is in byte 8 of the array.
- The Legend i On/Off control bit is in byte $8i + 12$ for $i = 1, \ldots, 14$.
- The Jth-bit of threshold digit i is in byte $32i + 8k + 100$, where $k = 0, 1, 2, 3$ for $j = 8, 4, 2, 1$, and $i = 1, 2, 3, 4$.


BYTE 0
BYTE 1
BYTE 2
BYTE 3
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MUX ORDER FORMAT
0 0 CC 3 CC 4 0 0 0 0 0 0 1 0 0 0 0 0 1 1 0 0 0 0 0 1 0 0 1 1 0 1 1 1 0
STATUS RETURNED FROM PREVIOUS MUX OPERATION
WD
MODE 1
TIMED RATE
CC3, CC4 INTERRUPT INHIBIT
x2C1
7930^4
S/C (N/A)
CONTROL CHANNEL 6
SLOTS 0, 1, 2
DATA WORD FORMAT
0/1 0 0 0 0/1 0 0 0 0 0 0 0 0/2 0 0 0 0 0 0 0 0 0 0 0 0
ALTERNATING STROBE SIGNAL
SIGNAL STATE 1
9-BIT ADDRESS
SIGNAL STATE 2

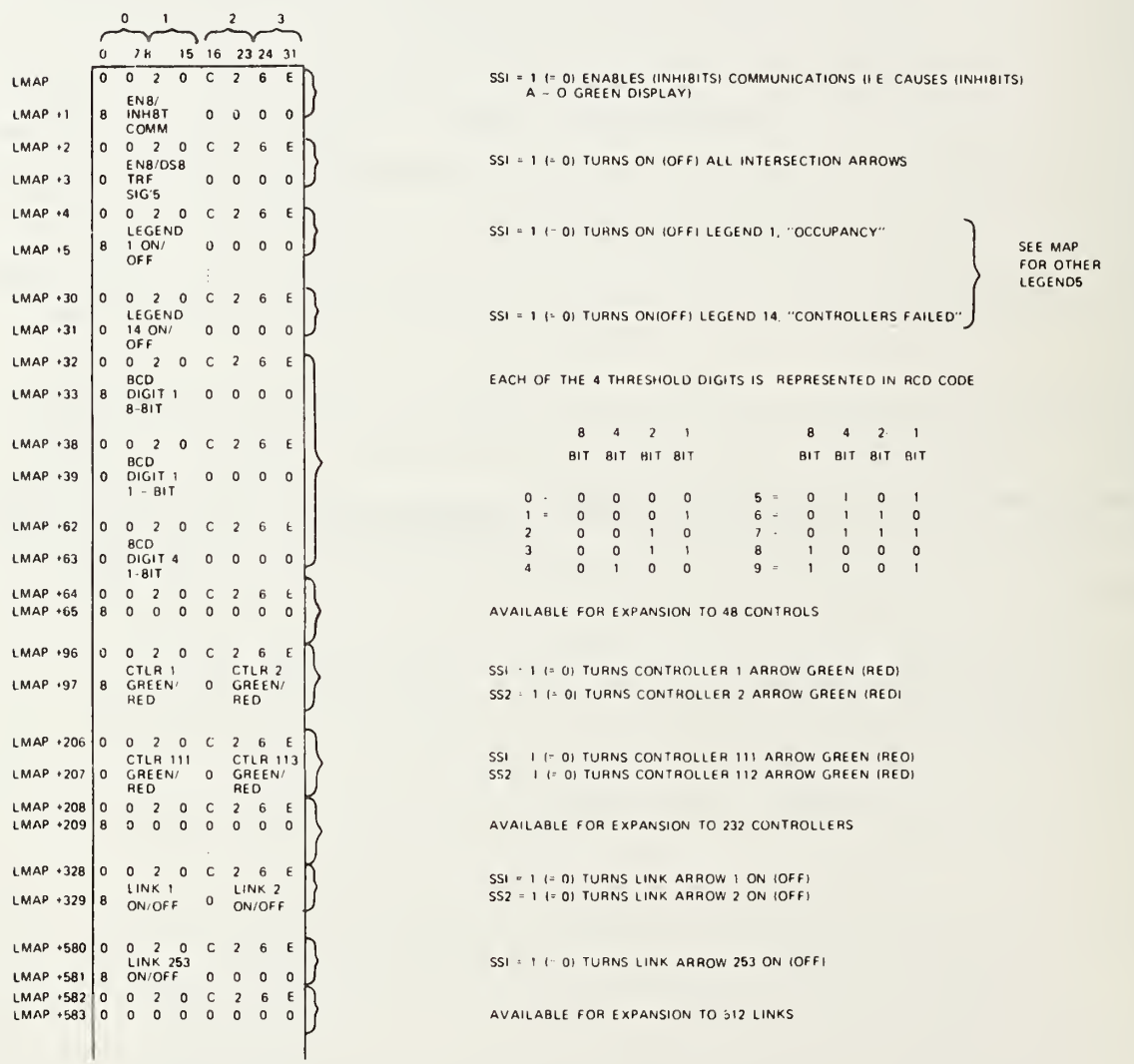

0 1 2 3
0 7 8 15 16 23 24 31
LMAP 0 0 2 0 C 2 6 E
LMAP +1 8 EN8/INH8T COMM 0 0 0 0
LMAP +2 0 0 2 0 C 2 6 E
LMAP +3 0 EN8/DS8 TRF SIG'S 0 0 0 0
LMAP +4 0 0 2 0 C 2 6 E
LMAP +5 8 LEGEND 1 ON/OFF 0 0 0 0
LMAP +30 0 0 2 0 C 2 6 E
LMAP +31 0 LEGEND 14 ON/OFF 0 0 0 0
LMAP +32 0 0 2 0 C 2 6 E
LMAP +33 8 BCD DIGIT 1 8-BIT 0 0 0 0
LMAP +38 0 0 2 0 C 2 6 E
LMAP +39 0 BCD DIGIT 1 1-BIT 0 0 0 0
LMAP +62 0 0 2 0 C 2 6 E
LMAP +63 0 BCD DIGIT 4 1-BIT 0 0 0 0
LMAP +64 0 0 2 0 C 2 6 E
LMAP +65 8 0 0 0 0 0 0 0
LMAP +96 0 0 2 0 C 2 6 E
LMAP +97 8 CTLR 1 GREEN/RED 0 CTLR 2 GREEN/RED
LMAP +206 0 0 2 0 C 2 6 E
LMAP +207 0 CTLR 111 GREEN/RED 0 CTLR 113 GREEN/RED
LMAP +208 0 0 2 0 C 2 6 E
LMAP +209 8 0 0 0 0 0 0 0
LMAP +328 0 0 2 0 C 2 6 E
LMAP +329 8 LINK 1 ON/OFF 0 LINK 2 ON/OFF
LMAP +580 0 0 2 0 C 2 6 E
LMAP +581 8 LINK 253 ON/OFF 0 0 0 0
LMAP +582 0 0 2 0 C 2 6 E
LMAP +583 0 0 0 0 0 0 0 0
SSI = 1 (= 0) ENABLES (INHIBITS) COMMUNICATIONS (I E CAUSES (INHIBITS) A - O GREEN DISPLAY)
SSI = 1 (= 0) TURNS ON (OFF) ALL INTERSECTION ARROWS
SSI = 1 (= 0) TURNS ON (OFF) LEGEND 1, "OCCUPANCY"
SSI = 1 (= 0) TURNS ON(OFF) LEGEND 14, "CONTROLLERS FAILED"
SEE MAP FOR OTHER LEGENDS
EACH OF THE 4 THRESHOLD DIGITS IS REPRESENTED IN BCD CODE
8 BIT 4 BIT 2 BIT 1 BIT
0 = 0 0 0 0
1 = 0 0 0 1
2 = 0 0 1 0
3 = 0 0 1 1
4 = 0 1 0 0
5 = 0 1 0 1
6 = 0 1 1 0
7 = 0 1 1 1
8 = 1 0 0 0
9 = 1 0 0 1
AVAILABLE FOR EXPANSION TO 48 CONTROLS
SS1 = 1 (= 0) TURNS CONTROLLER 1 ARROW GREEN (RED)
SS2 = 1 (= 0) TURNS CONTROLLER 2 ARROW GREEN (RED)
SS1 = 1 (= 0) TURNS CONTROLLER 111 ARROW GREEN (RED)
SS2 = 1 (= 0) TURNS CONTROLLER 112 ARROW GREEN (RED)
AVAILABLE FOR EXPANSION TO 232 CONTROLLERS
SS1 = 1 (= 0) TURNS LINK ARROW 1 ON (OFF)
SS2 = 1 (= 0) TURNS LINK ARROW 2 ON (OFF)
SSI = 1 (= 0) TURNS LINK ARROW 253 ON (OFF)
AVAILABLE FOR EXPANSION TO 512 LINKS

Figure 10. Map Signal Output Array

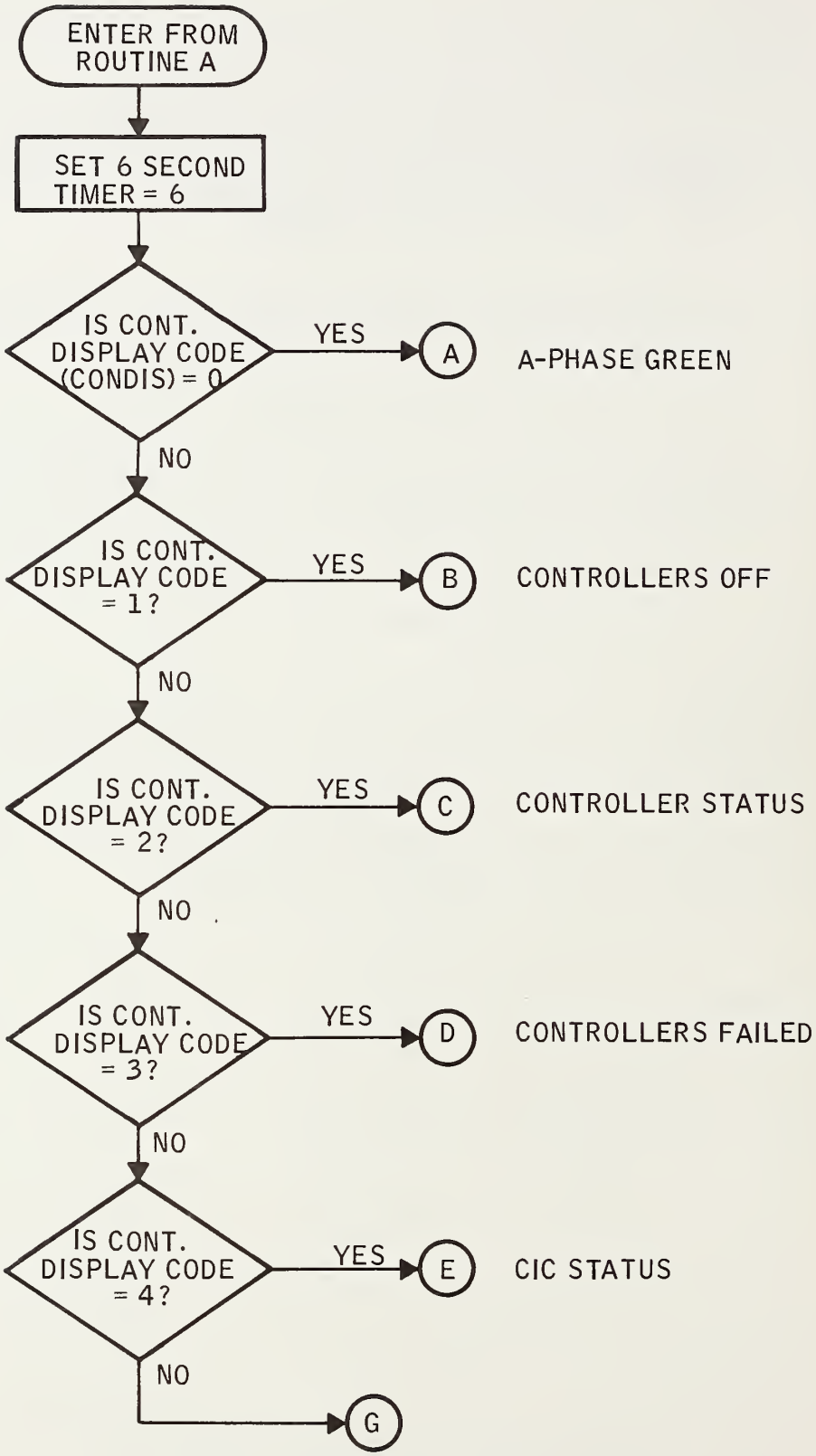
The Controller I green/red control is in byte 8 [(i = 1)/2] + k + 388, where [x] denotes the integer part of x, where k = 0 for i odd and k = 2 for i even, and where i = 1,..., 112 for the present system.

The Link Arrow i On/Off control is in byte 8 [(i = 1/2] + k + 1316, where [x] denotes the integer part of x, where k = 0 for i odd and k = 2 for i even, and where i = 1,..., 253 for the present system. When Routine J determines that Link Arrow is to be on, it clears bit 4 of byte i = 1 of the internal byte array, LNKARW, each byte of which is set to X'00' at every entry of Routine J. After the Surveillance Display has been completely formatted, J replaces the state bit for Link Arrow i in the LMAP array by the state bit from byte i - 1 of the LNKARW array, for i = 1,..., 253.

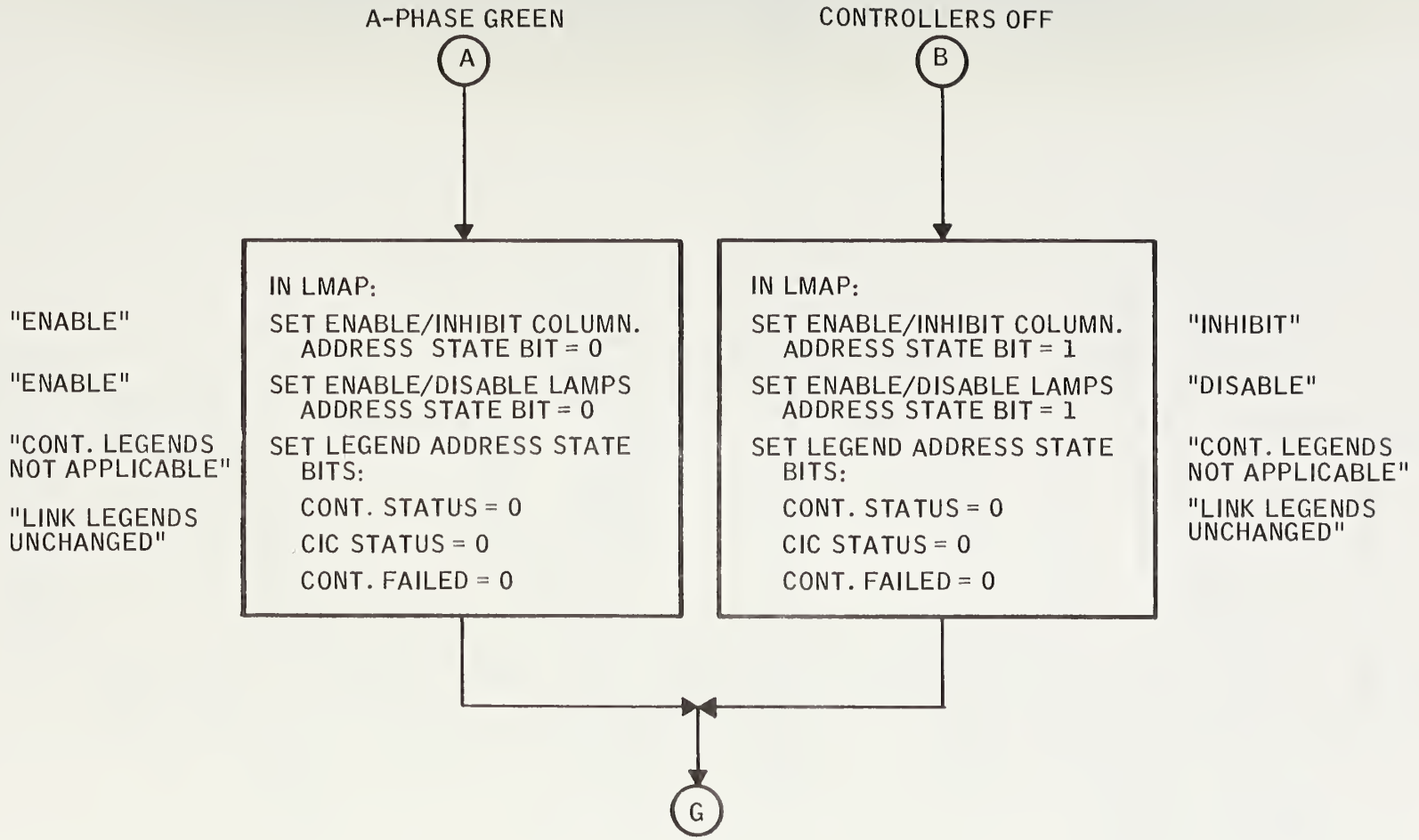
Link Arrow Arrays -- Two arrays provide the necessary cross-references between vehicle detector numbers and link arrow numbers (DETDSP); between link numbers and link arrow numbers (LNKDSP). Each is a byte array whose ith entry is the index of the LNKARW array entry containing the state bit for the ith detector or link, respectively.

2.6.32.5 Listing

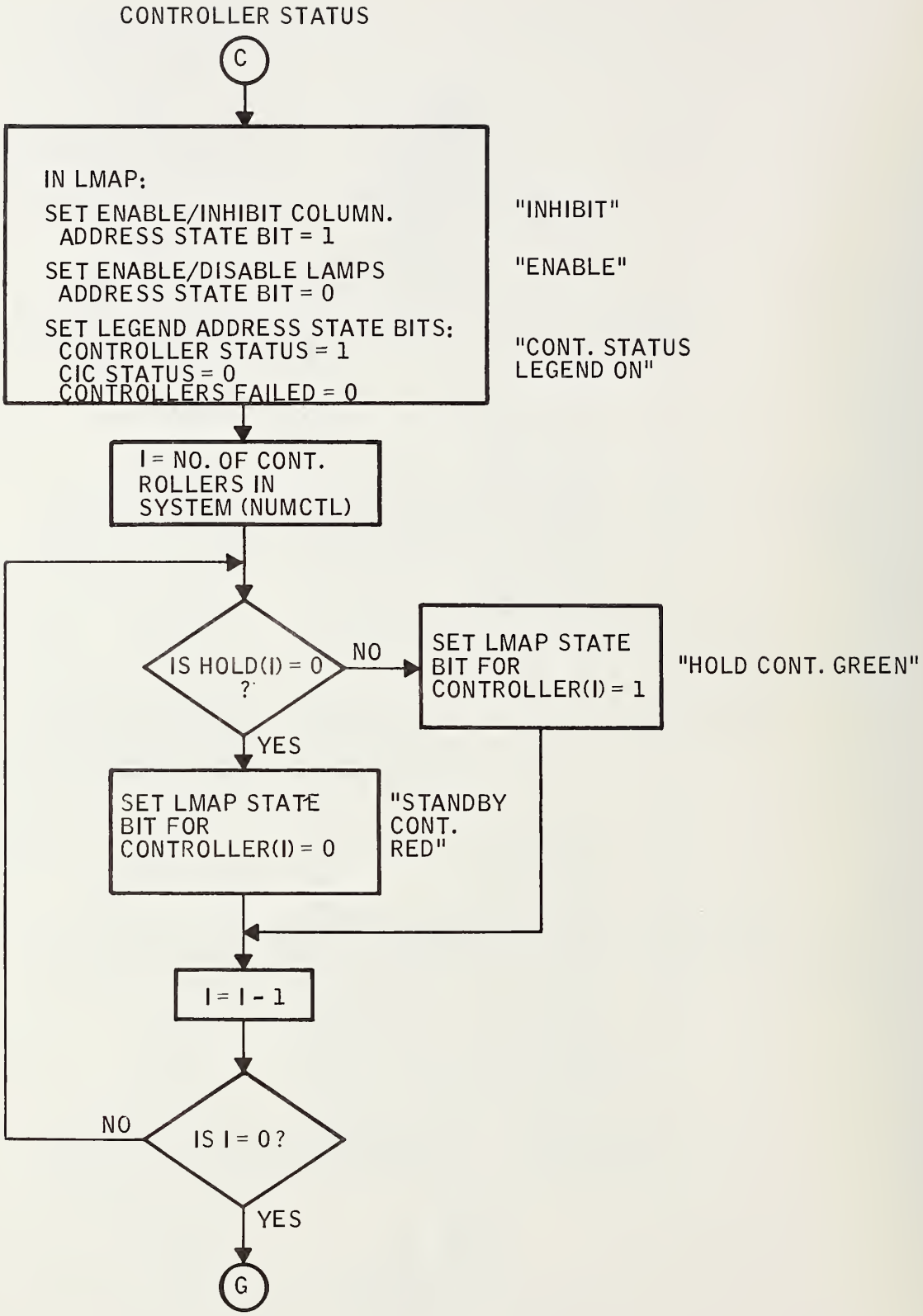
See Volume III, 2GCF Routine Listings.


ENTER FROM ROUTINE A
SET 6 SECOND TIMER = 6
IS CONT. DISPLAY CODE (CONDIS) = 0
YES
A
A-PHASE GREEN
NO
IS CONT. DISPLAY CODE = 1?
YES
B
CONTROLLERS OFF
NO
IS CONT. DISPLAY CODE = 2?
YES
C
CONTROLLER STATUS
NO
IS CONT. DISPLAY CODE = 3?
YES
D
CONTROLLERS FAILED
NO
IS CONT. DISPLAY CODE = 4?
YES
E
CIC STATUS
NO
G

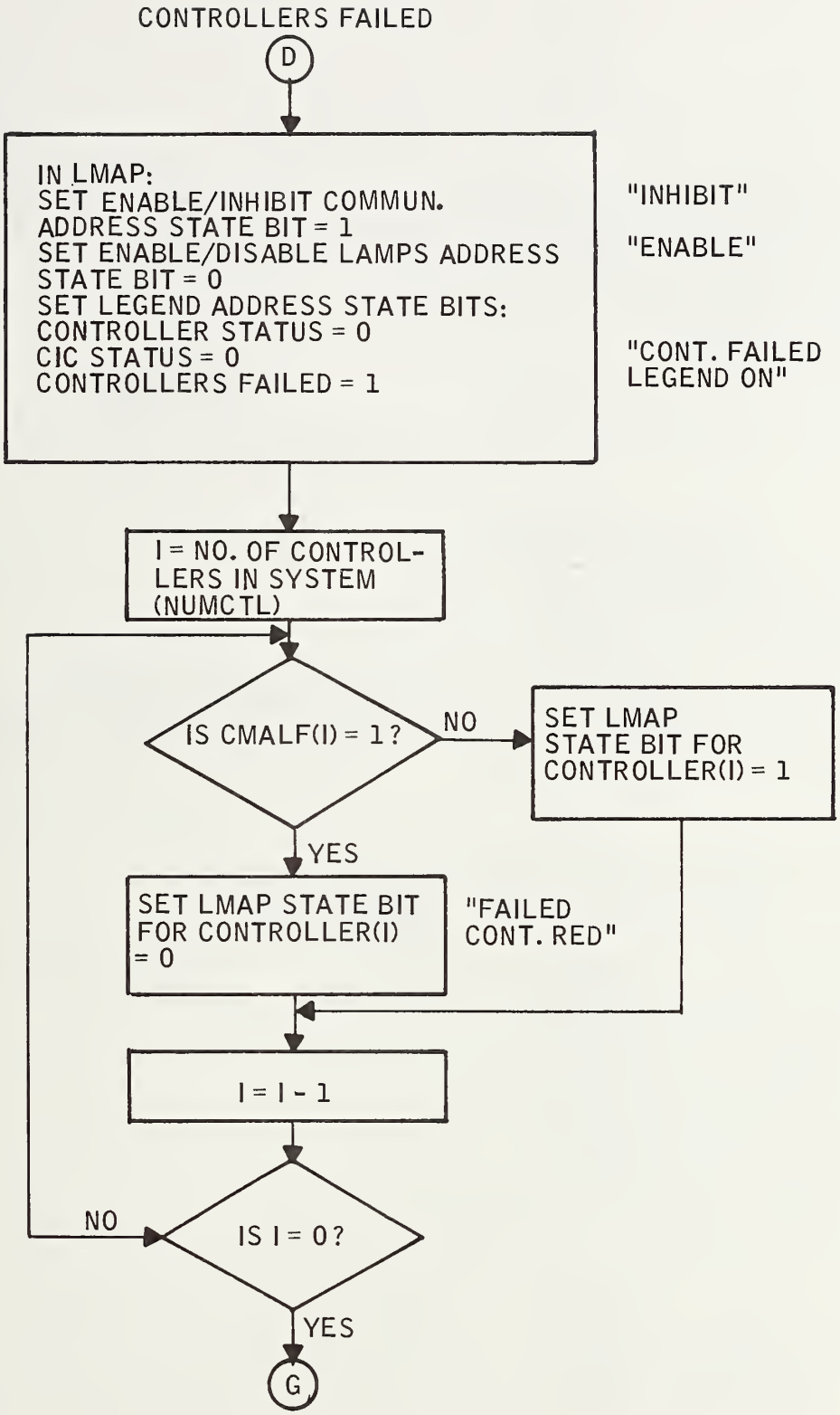
Routine J



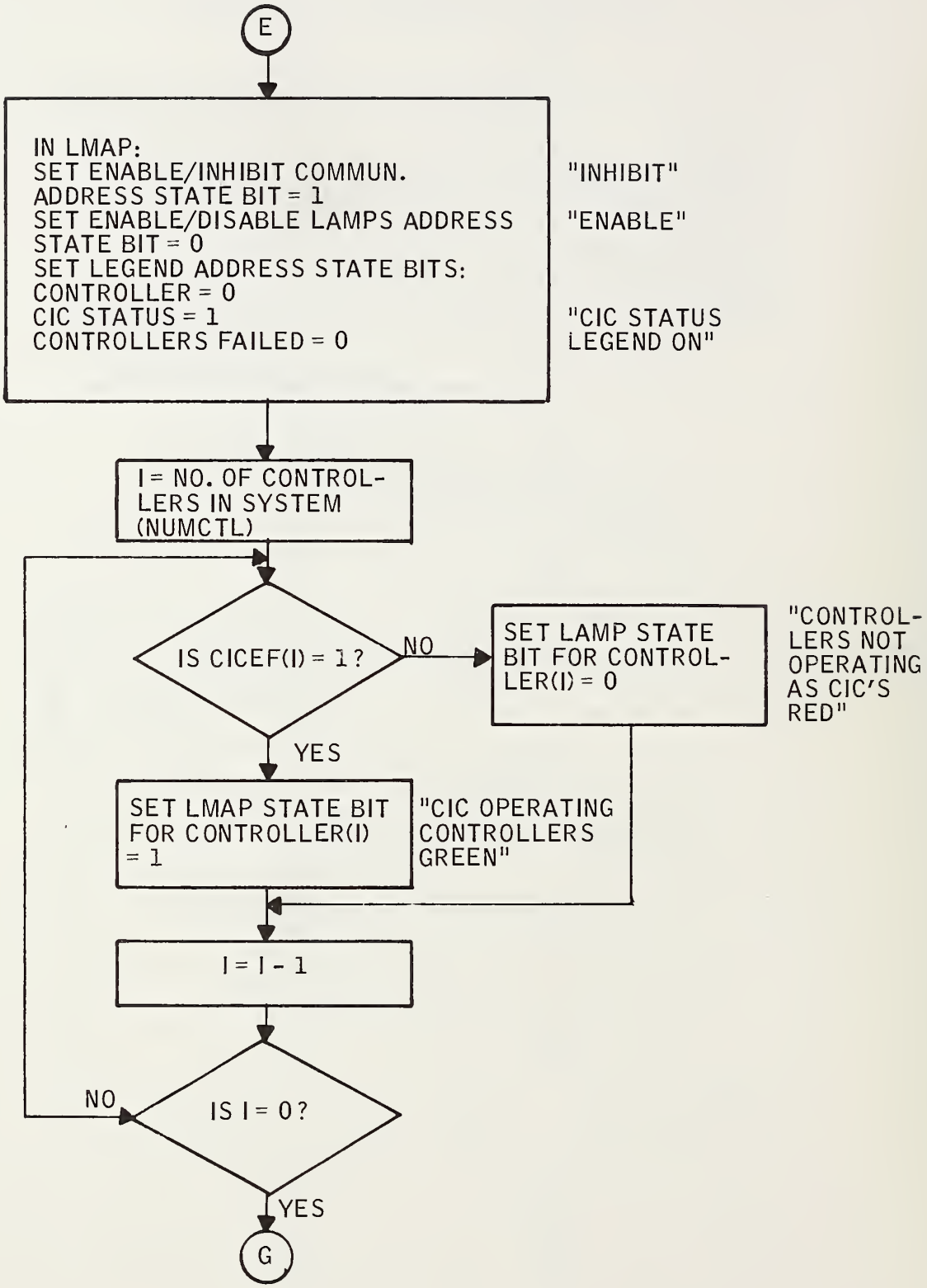
Routine J (Continued)


CONTROLLER STATUS
C
IN LMAP:
SET ENABLE/INHIBIT COLUMN. ADDRESS STATE BIT = 1
"INHIBIT"
SET ENABLE/DISABLE LAMPS ADDRESS STATE BIT = 0
"ENABLE"
SET LEGEND ADDRESS STATE BITS: CONTROLLER STATUS = 1 CIC STATUS = 0 CONTROLLERS FAILED = 0
"CONT. STATUS LEGEND ON"
I = NO. OF CONT. ROLLERS IN SYSTEM (NUMCTL)
IS HOLD(I) = 0 ?
NO
SET LMAP STATE BIT FOR CONTROLLER(I) = 1
"HOLD CONT. GREEN"
YES
SET LMAP STATE BIT FOR CONTROLLER(I) = 0
"STANDBY CONT. RED"
I = I - 1
NO
IS I = 0 ?
YES
G

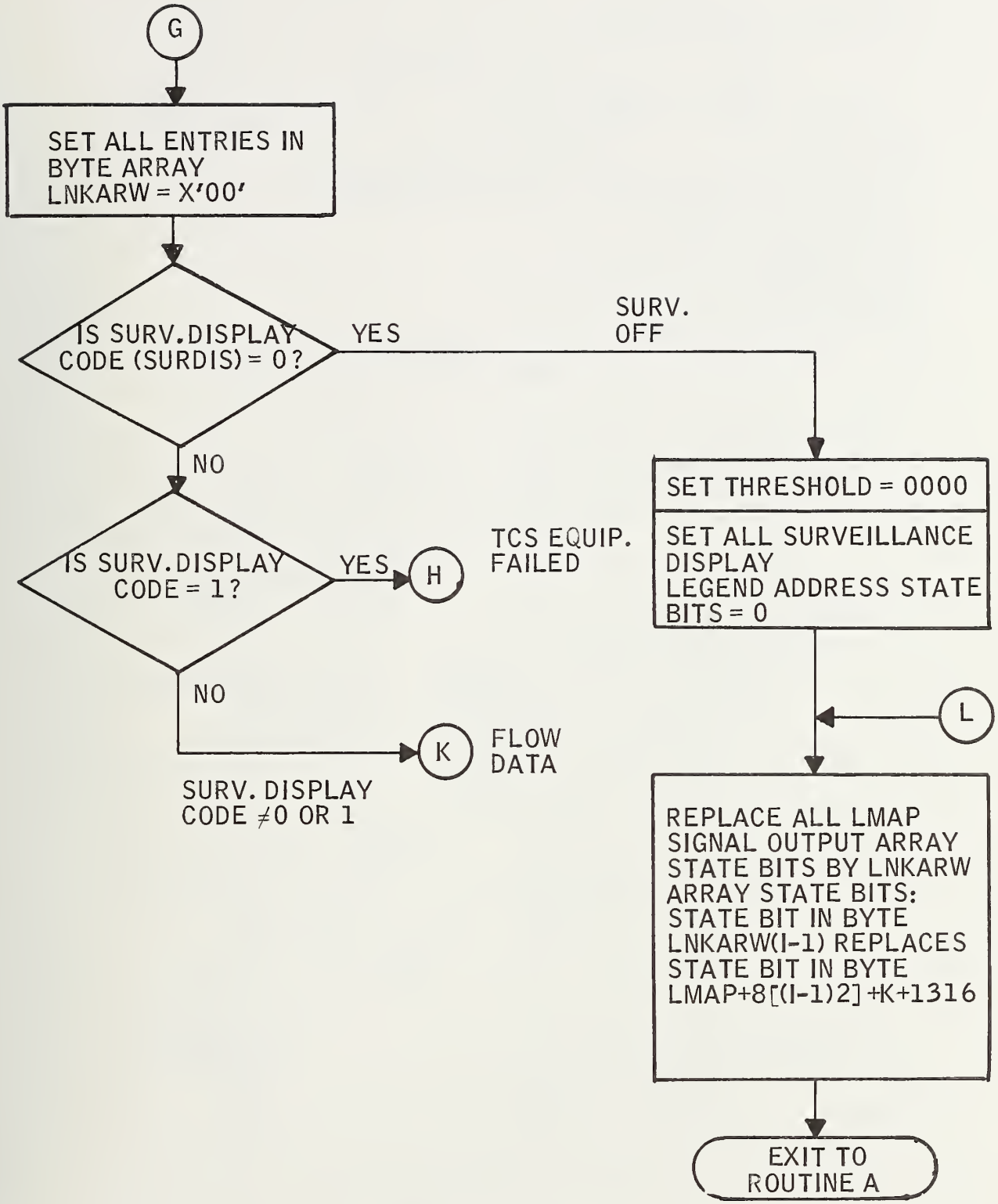
Routine J (Continued)



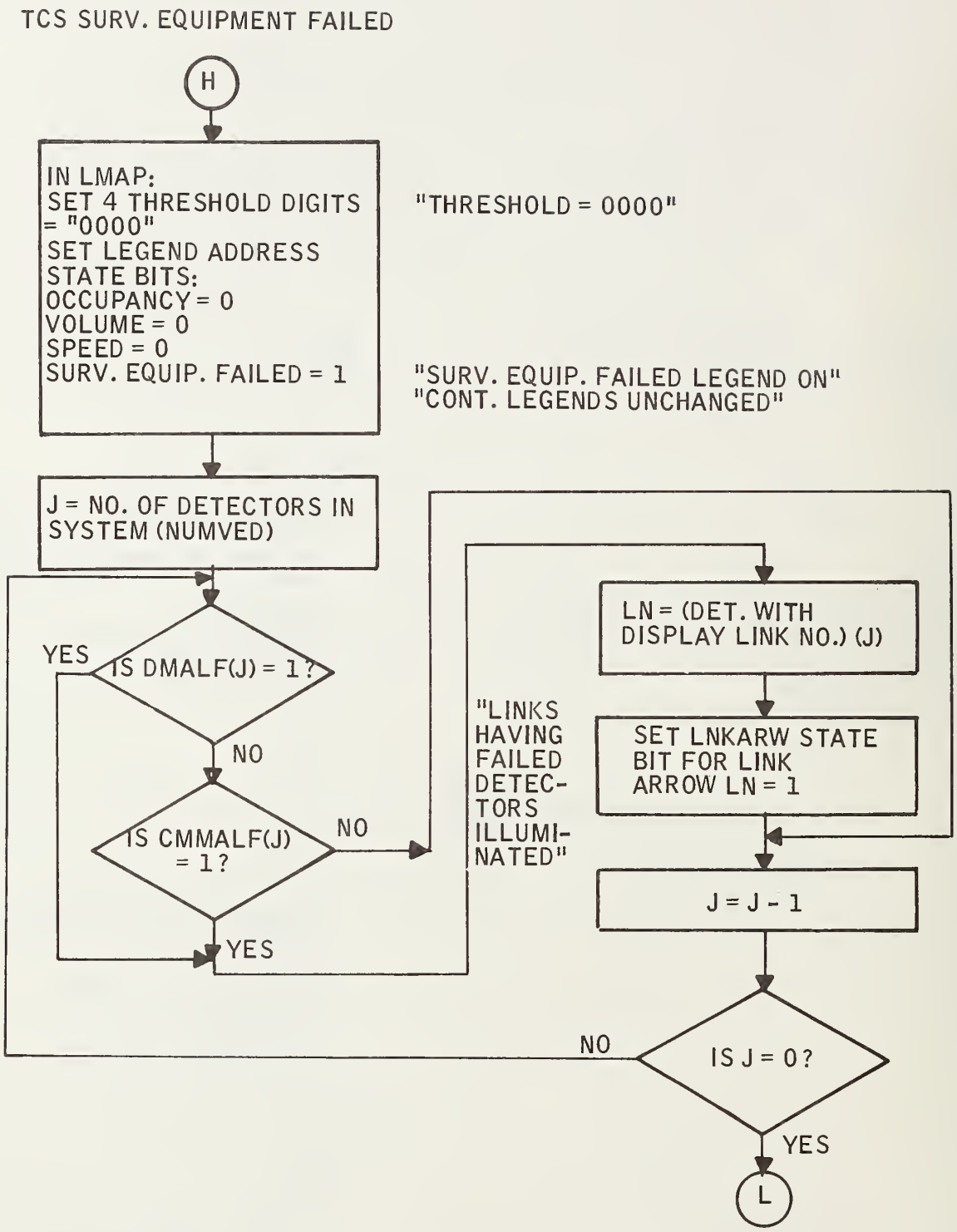
Routine J (Continued)



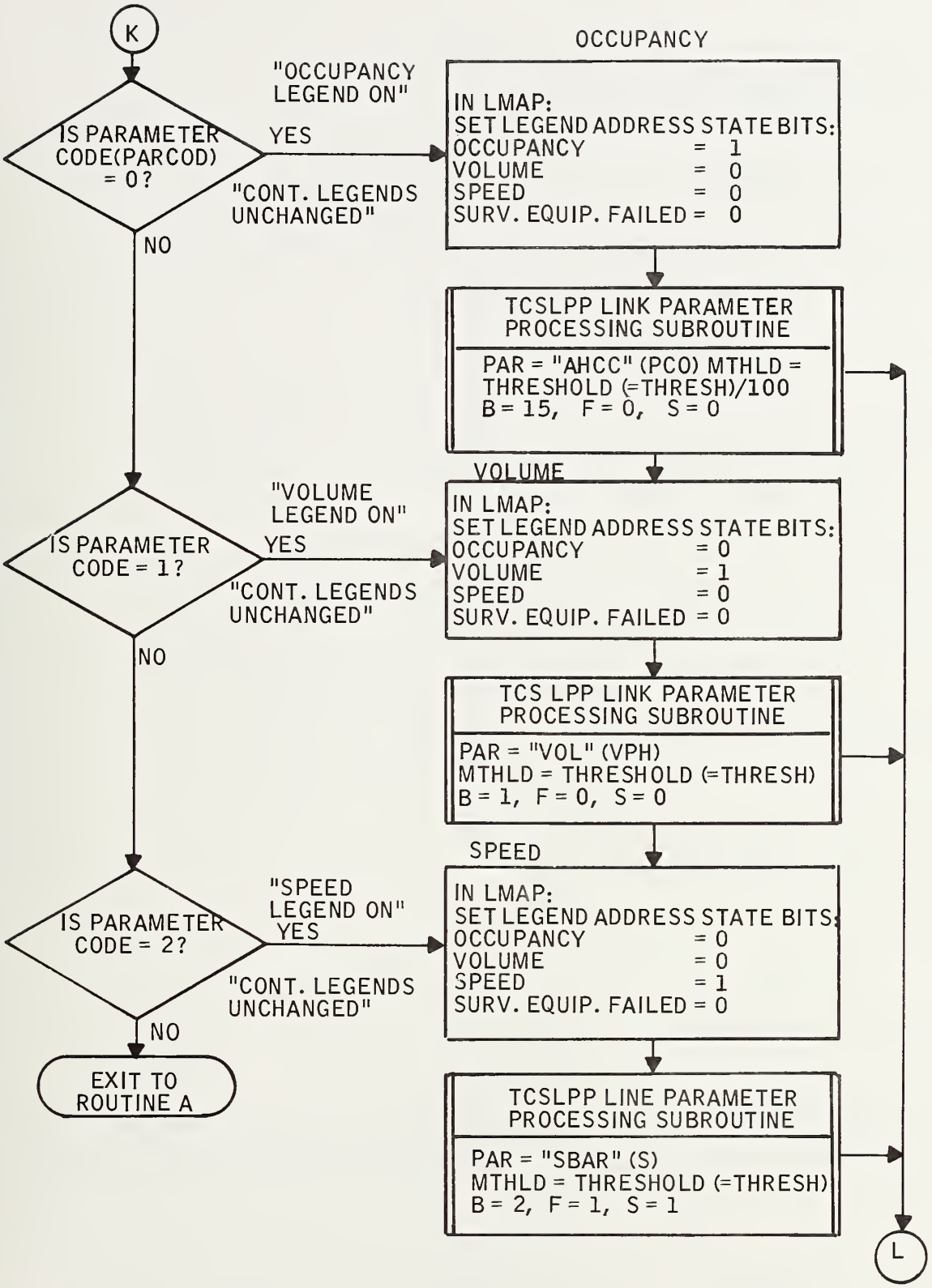
Routine J (Continued)


G
SET ALL ENTRIES IN BYTE ARRAY LNKARW = X'00'
IS SURV.DISPLAY CODE (SURDIS) = 0?
YES
SURV. OFF
NO
SET THRESHOLD = 0000
SET ALL SURVEILLANCE DISPLAY LEGEND ADDRESS STATE BITS = 0
IS SURV.DISPLAY CODE = 1?
YES
H
TCS EQUIP. FAILED
NO
K
FLOW DATA
SURV. DISPLAY CODE ≠0 OR 1
L
REPLACE ALL LMAP SIGNAL OUTPUT ARRAY STATE BITS BY LNKARW ARRAY STATE BITS: STATE BIT IN BYTE LNKARW(I-1) REPLACES STATE BIT IN BYTE LMAP+8[(I-1)2]+K+1316
EXIT TO ROUTINE A

Routine J (Continued)



Routine J (Continued)



Routine J (Concluded)

2.6.33 SUBROUTINE BCDTH

2.6.33.1 Purpose

To enter threshold value in map array.

2.6.33.2 Relationship

This subroutine is called from routines J and TCSLP by:

```
CALL BCDTH (MX, LA)
```

where:

MX = The integer to be stored

LA = The array where the integer is to be stored.

This subroutine calls PTBI.

2.6.33.3 Assumption

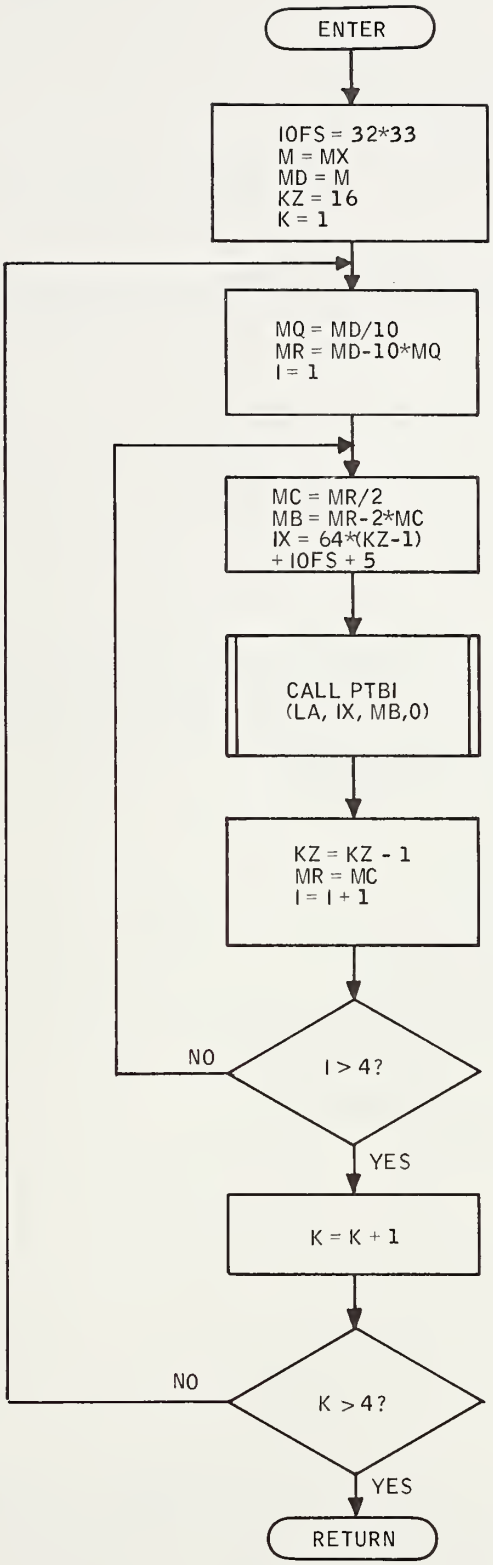
None.

2.6.33.4 Approach

Subroutine BCDTH converts the positive binary integer MTHLR ($\leq$ 9999) to BCD and stores the resulting bit configuration in the Map Signal Output Array.

2.6.33.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine BCDTH

2.6.34 SUBROUTINE CDL

2.6.34.1 Purpose

This subroutine sets controller display switches and legends.

2.6.34.2 Relationship

This subroutine is called from Routine J by:

CALL CDL (I, J, K, LA)

where:

I = Desired state of the enable/inhibit communication address bit.
J = Desired state of the enable/inhibit lamps address bit.
K = Index to desired map legend
  K = 1 = Controller status
  K = 2 = CIC status
  K = 3 = BPS status
  K = 4 = Controllers failed
  K = 15 = A-phase green
LA = Output array of display control bits

This subroutine calls subroutine PTBI.

2.6.34.3 Assumption

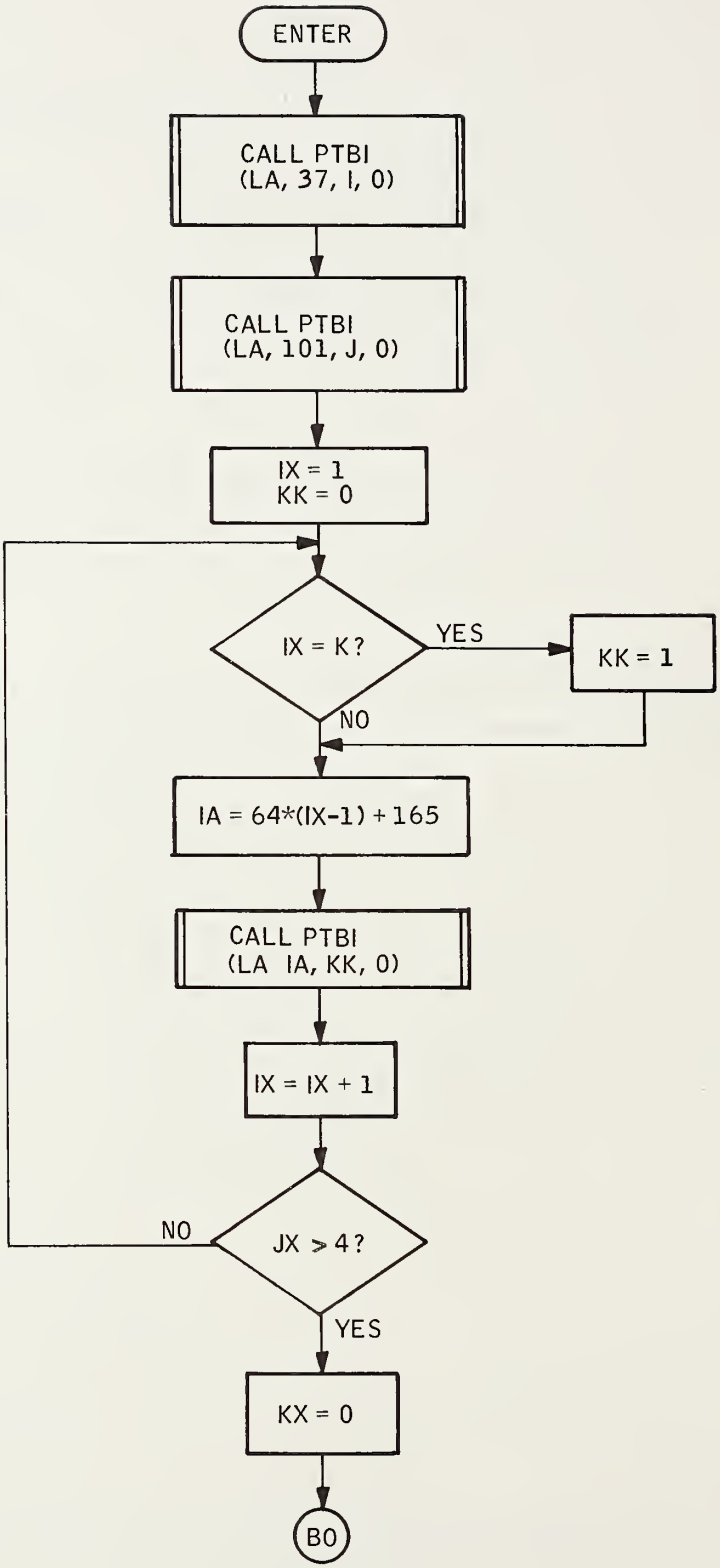
System integrity is assumed.

2.6.34.4 Approach

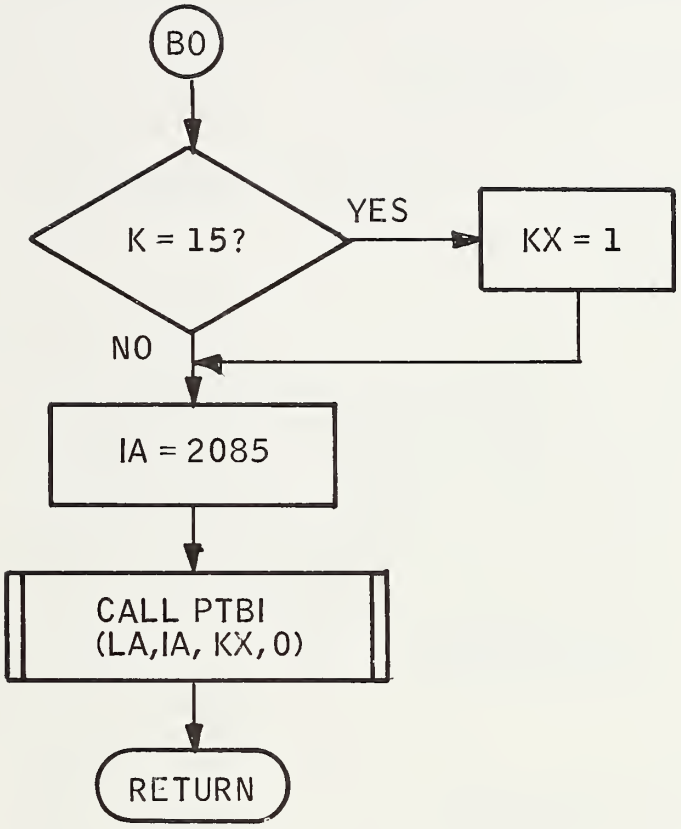
Subroutine CDL begins by setting the enable/inhibit communication address bit and the enable/inhibit lamps address bit to the desired states. The appropriate bits to light the desired legend display are then set. Subroutine CDL then returns to the calling routine.

2.6.34.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine CDL



Subroutine CDL (Concluded)

2.6.35 SUBROUTINE CLS

2.6.35.1 Purpose

This subroutine sets controller lamp states.

2.6.35.2 Relationship

This subroutine is called from Routine J by:

CALL CLS (N, LA, IC)

where:

N = controller.
IC = state of controller.
LA = output to lamps.

This routine calls GETBI, PTBI.

2.6.36.3 Assumption

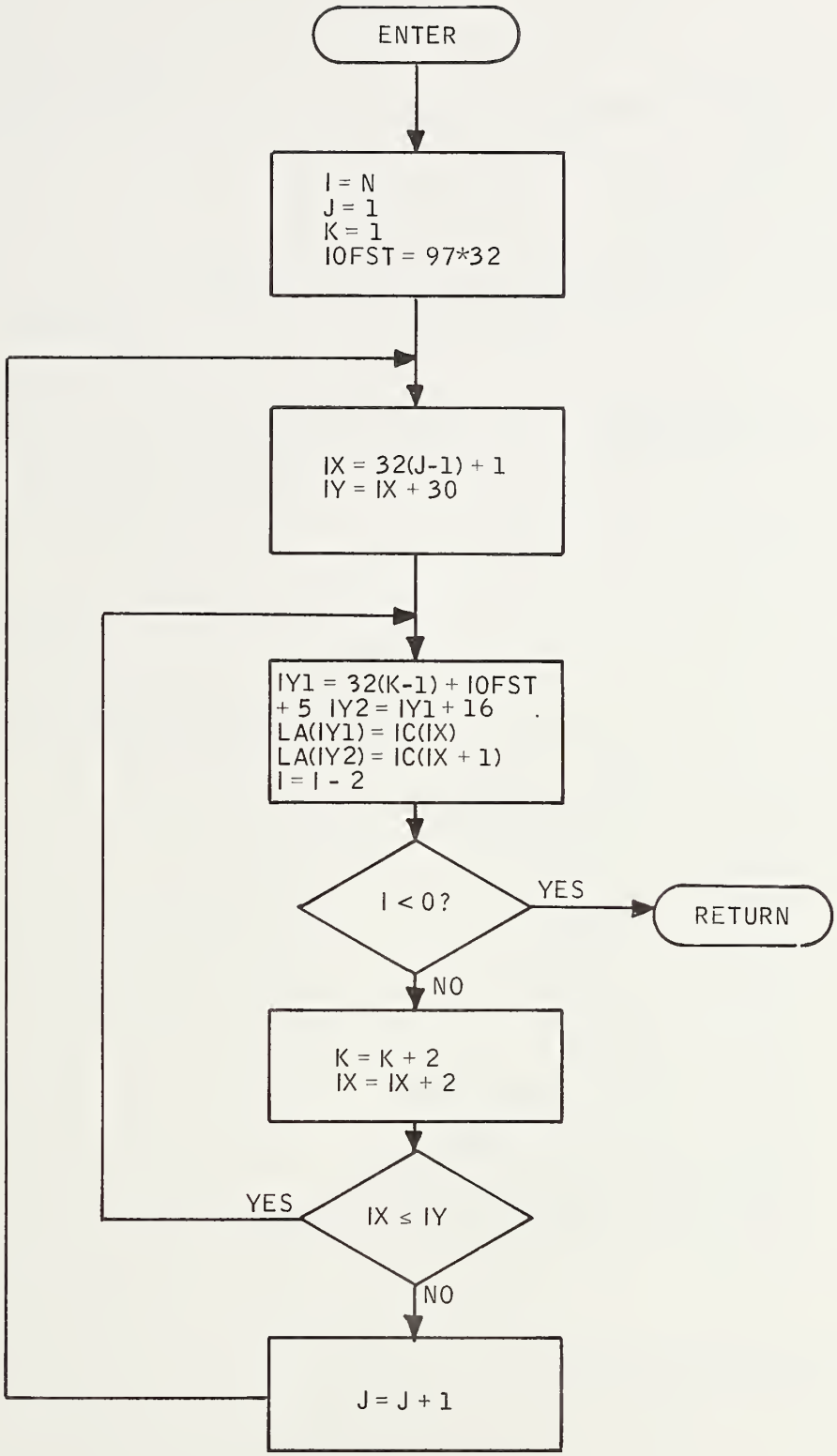
None.

2.6.35.4 Approach

CLS addresses the half-words in words 97 to 209 of the Map Signal Output Array (LMAP). The state of the controller (IC) is then stored in the appropriate halfword of LMAP. CLS returns to the calling routine.

2.6.35.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine CLS

2.6.36 SUBROUTINE SDL

2.6.36.1 Purpose

Subroutine SDL sets surveillance display legends.

2.6.36.2 Relationship

This subroutine is called by:

```
CALL SDL (I, LA)
```

where:

I = pointer to legend arrays

- Legend 5 = occupancy
- Legend 6 = volume
- Legend 7 = speed
- Legend 8 = queue
- Legend 9 = stops
- Legend 10 = delay
- Legend 11 = passenger gain
- Legend 12 = buses helped
- Legend 13 = surv equip failed
- Legend 14 = BPS surv equip failed

LA = Array

This subroutine calls PTBI.

2.6.36.3 Assumption

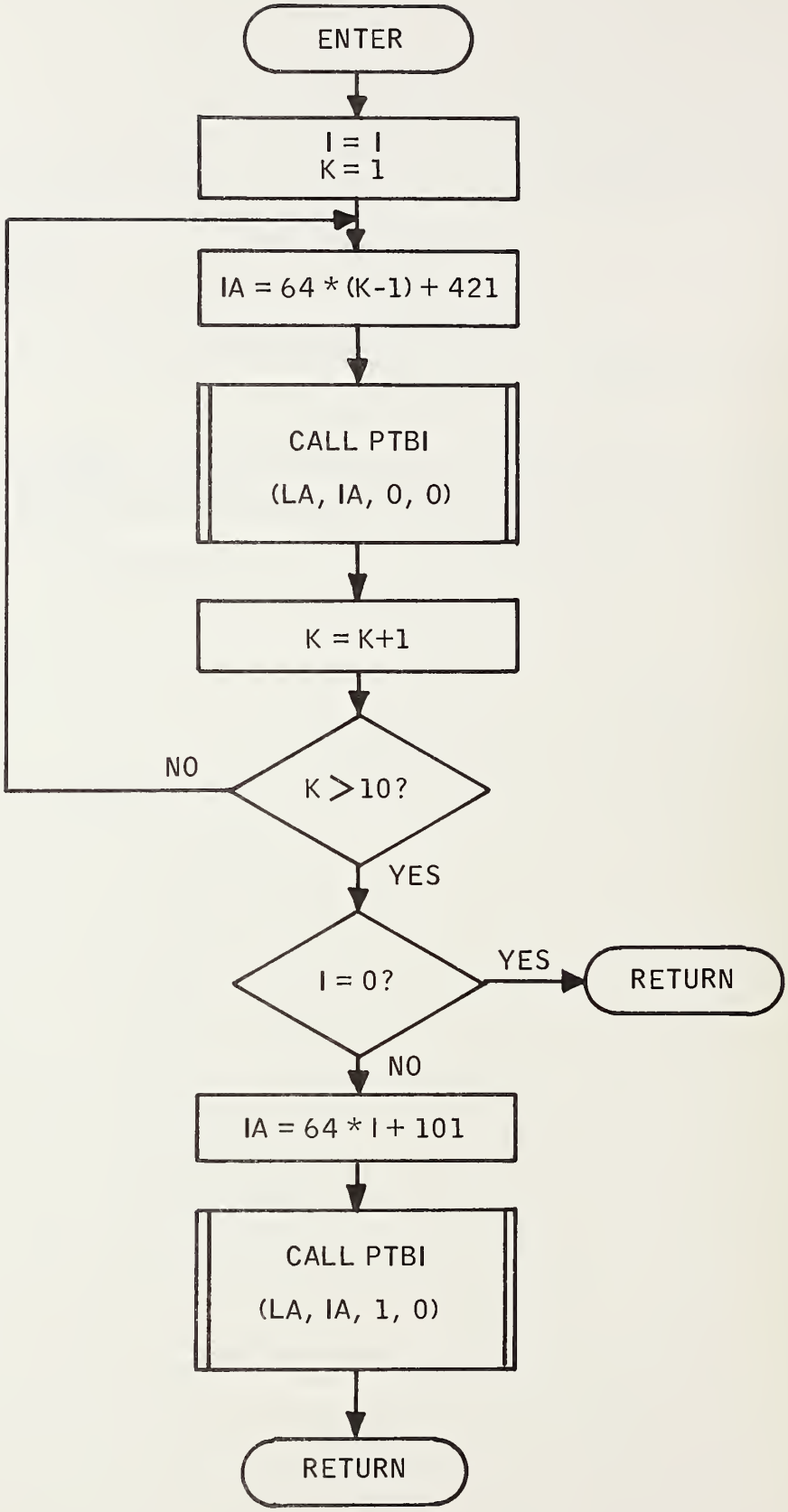
None.

2.6.36.4 Approach

Ten bits in the specified array (LA) are cleared. The bit in LA that corresponds to the specified surveillance legend (I) is also cleared. SDL then returns to the calling routine.

2.6.36.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine SDL

2.6.37 SUBROUTINE TCSLP

2.6.37.1 Purpose

Subroutine TCSLP is a link processing subroutine.

2.6.37.2 Relationship

TCSLP is called from Routine J by:

```
CALL TCSLP (LP, MT, IF, NL, LD, LR, LA, ITR)
```

where:

LP = link parameter byte array
MT = link threshold value
IF = Program control flag
  0 = byte control
  1 = halfword oriented
NL = Program control flag
  0 = link arrows illuminated if and only if the corresponding link's parameter exceeds threshold value
  1 = link arrows illuminated if and only if the corresponding link's parameter is less than the threshold value.
LR = Link arrow state bit
LA = Output array of display control bits
ITR = Return status

TCSLP calls Subroutine BCDTH.

2.6.37.3 Assumption

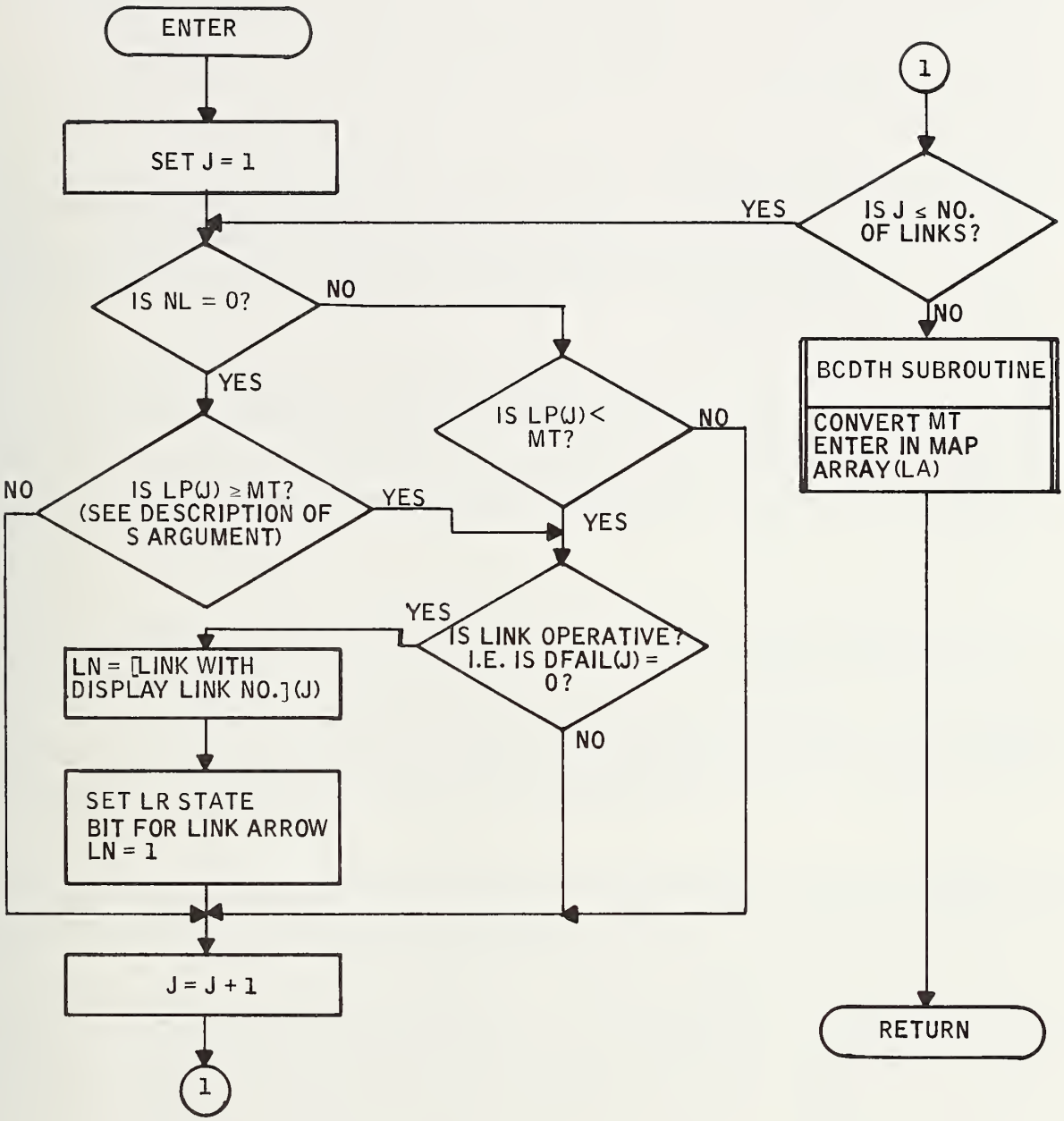
None.

2.6.37.4 Approach

Subroutine TCSLP compares a Traffic Control System parameter value for each link with a threshold value, MT. The link parameters are stored in a halfword (LD = 0) or byte (LD = 1) array starting at location LP. If the flag NL is zero, a link arrow is illuminated if and only if the corresponding link parameter exceeds the threshold value. If NL is non-zero, the arrow is illuminated if and only if the parameter is less than the threshold.

2.6.37.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine TCSLP

2.6.38 ROUTINE K

2.6.38.1 Purpose

Routine K examines data and commands formatted in Routine M in accordance with the display controls set at the Operator's Control Panel. The routine executes these commands to cause the selected display to be presented by the CRT device.

The Routine K Failure Table Updating function remains in core during system operation. This portion of the routine maintains the controller and detector failure tables up to date based on inputs from other operational routines.

2.6.38.2 Relationship

Routine K is entered whenever the operator calls for a change and at 25-second intervals. It is entered from the Level 3 Executive Routine.

The Failure Table Updating Add Function, Subroutine KFTU, is entered from Routine K through the use of indicator flags set by Routines P and E.

The Failure Table Updating Failure Acknowledge/Failure Repair function, Subroutine KFMT, is entered from the Manual Control Panel Processing Routine. The CRT control and Data Formatting Routine is divided into the following subroutines: TODAY, DISIN, CNVT, SETCR, DISNM, SCODE, DCMAL, CRLF, CIC, GREEN, TRIG. These subroutines are called by Routine K.

2.6.38.3 Assumption

None.

2.6.38.4 Approach

(The capability to generate BPS CRT displays has been deleted.)

The Failure Status Display (Figure 11) presents all the controller, detector, and communications failures currently recognized by the UTCS. The type, equipment identification number, time and date, and acknowledge status of each failure are contained in the Failure Table which is updated by two subroutines of Routine K.

The System Status Display (Figure 12) presents, for each section in the traffic control system, its current operating mode and pattern, the time and desired mode of the latest valid operator mode change request, the numbers of CIC intersections in operation, and the numbers of detector and controller failures.

The Controller Status Display (Figure 13) lists the identification number and status for each traffic system controller in standby, or designated as a CIC controller by the operator but inhibited from CIC operation because of the time-of-day, or currently operating as a CIC controller. Controllers operating under traffic system control but which have not been designated as CIC controllers are not listed.

The Detector Status Display (Figure 14) lists all detectors in stand-by or which have failed. Detectors operating normally are not listed.

PAGE DESCRIPTION: FAILURE STATUS
DISPLAY CODE: 1

NOTE. FAILURES ARE LISTED IN REVERSE CHRONOLOGICAL ORDER WITH THE RIGHT HALF ON THE PAGE A CONTINUATION OF THE LEFT HALF.

TIME: 12:24

FAILURE STATUS

TYPE①	NO.②	TIME③	MONTH④	DAY⑤	ACK⑥	TYPE	NO.	TIME	MONTH	DAY	ACK.
DET	126	0900	FEB	4	N	DET	12	1401	JAN	30	Y
CONT	64	0842	FEB	4	N	COMM	161	1400	JAN	30	Y
COMM	213	2231	FEB	3	N	DET	14	0958	JAN	30	N
DET	33	1827	FEB	1	Y	CONT	14	0936	JAN	29	N
						CONT	120	0903	DEC	25	Y

ALL NORMAL⑦

TRUNCATED LIST – TOTAL NUMBER⑧ = 53⑨

① TYPE: BYTE 1 OF FAILURE TABLE (FLTAB) ENTRY
TYPE CODES:
3 = CONT = CONTROLLER
4 = DET = DETECTOR
5 = COMM = COMMUNICATION

② EQUIPMENT NO: BYTES 2 AND 3 OF FLTAB ENTRY

③ TIME OF FAILURE: BYTES 5, 6, 7 AND 8 OF FLTAB ENTRY

④ MONTH OF FAILURE: BYTES 10, 11, AND 12 OF FLTAB ENTRY

⑤ DAY OF FAILURE: BYTES 14 AND 15 OF FLTAB ENTRY

⑥ ACKNOWLEDGE CODE: BYTE 0 OF FLTAB ENTRY
0 = N = NO
1 = Y = YES

⑦ THIS MESSAGE IS DISPLAYED WHEN NO SYSTEM FAILURES ARE PRESENT

⑧ THIS MESSAGE IS DISPLAYED WHEN THE NUMBER OF SYSTEM FAILURES EXCEEDS CRT PAGE CAPACITY (38 FAILURES).

⑨ NUMBER OF SYSTEM FAILURES (NOFAL).

Figure 11. Failure Status Format

PAGE DESCRIPTION: SYSTEM STATUS
DISPLAY CODE: 2

TIME: 12:24

SYSTEM STATUS

HISTORY ON①

SECT.	TIME②	DESIRED③ MODE	ACTUAL④ MODE	PATTERN⑤ NO.	CIC⑦ IN OP.	FAILURES⑧ DET.	FAILURES⑧ CONT.
1	0905	TRSP	TRSP	7	2	0	0
2	1003	MAN	MAN	3	5	1	0
3	0905	TOD	TOD	5	14	10	2
4	1102	STBY	STBY	1⑥	6	3	0

① HISTORY CODE: (HRF)
0 = OFF
1 = ON

② TIME OF MODE CHANGE: (TIMCH)

③ DESIRED MODE: (DMODE)
0 = STBY = STANDBY
1 = MAN = MANUAL
2 = TOD = TIME OF DAY
3 = TRSP = TRAFFIC RESPONSIVE
MODE REQUESTED BY OPERATOR AT TIME SHOWN.

④ ACTUAL MODE: (MODES)
CODES SAME AS ③
CURRENT OPERATING MODE OF SECTION.

⑤ PATTERN NUMBER: (PATNM)
CURRENT PATTERN BEING IMPOSED OR TRANSITIONED TO.

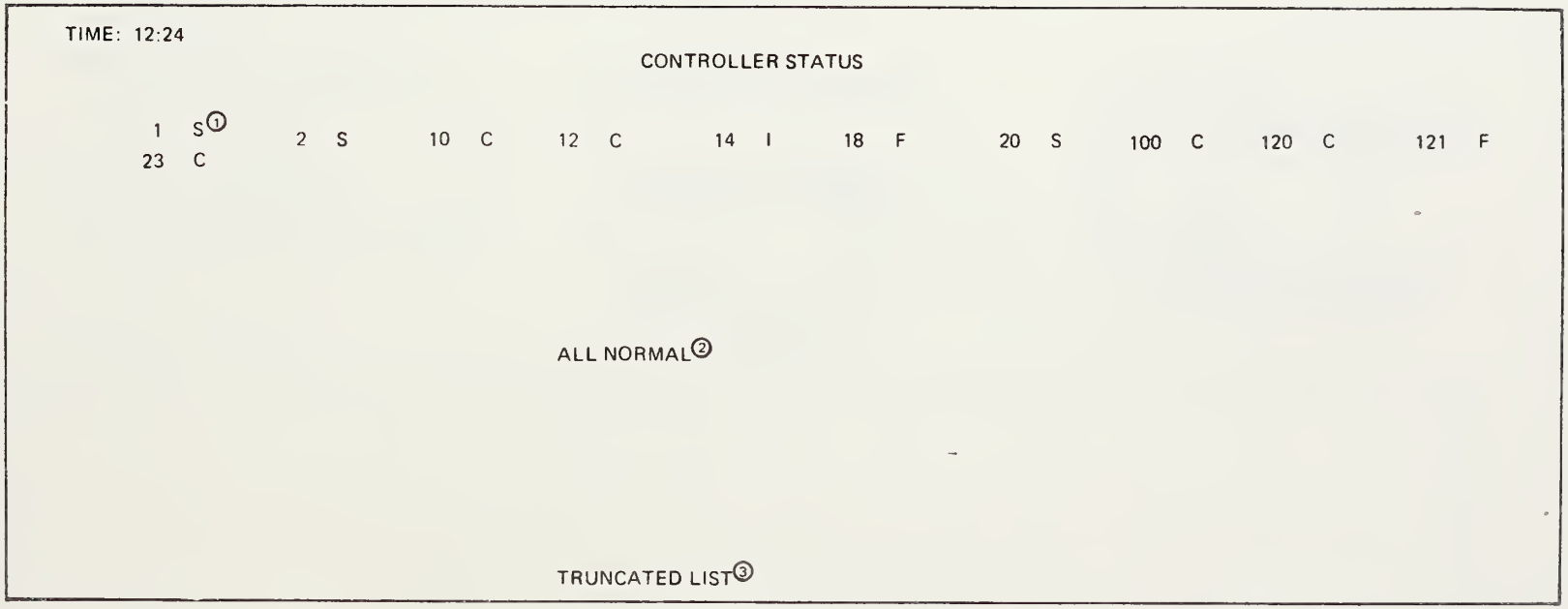
⑥ WHEN MODE IS STBY-PATTERN NUMBER INDICATES CURRENT VALID TOD PATTERN.

⑦ CIC:
VALUES ARE COMPUTED AT DISPLAY TIME. INDICATES ALL CONTROLLERS SELECTED FOR CIC ARE NOT INHIBITED.

⑧ DETECTOR AND CONTROLLER FAILURES: (SECFC AND SCDFC)
CURRENT NUMBER OF FAILURES IN EACH SECTION.

Figure 12. System Status Format

PAGE DESCRIPTION: CONTROLLER STATUS
DISPLAY CODE: 3



① CONTROLLER STATUS CODES:
S = STANDBY (HOLD)
F = FAILED (CMALF)
C = OPERATING CIC (CICEF)
I = INHIBITED CIC (CICSF ∩ $\overline{\text{CICEF}}$)

② MESSAGE DISPLAYED WHEN ALL CONTROLLERS ARE ON LINE AND NONE HAVE BEEN SELECTED FOR CIC

③ MESSAGE DISPLAYED WHEN NUMBER OF ENTRIES EXCEEDS CRT PAGE CAPACITY (230 CONTROLLERS)

Figure 13. Controller Status Report

PAGE DESCRIPTION: DETECTOR STATUS
DISPLAY CODE: 4

TIME: 12:24

DETECTOR STATUS

1	S①	3	S	5	S	13	D	27	C	106	S	412	C	461	D				

ALL NORMAL②

TRUNCATED LIST③

① DETECTOR STATUS CODES:
S = STANDBY (DIS)
D = DETECTOR FAILED (DMALF)
C = COMMUNICATION FAILED (CMMAL)

② MESSAGE DISPLAYED WHEN ALL DETECTORS ARE ON LINE

③ MESSAGE DISPLAYED WHEN NUMBER OF ENTRIES EXCEEDS CRT PAGE CAPACITY (230 DETECTORS)

Figure 14. Detector Status Report

The CRT Intersection Status Display (Figure 15) provides a variety of information on a selected intersection, the intersection being identified by its controller number. The information presented includes the number of the section of which the intersection is a member, the number of phases at the intersection, and the duration of the intervals in the controller cycle. The cycle length, offset value, and the lengths of the variable green intervals for A- and B-Phase are also displayed along with minimum values of A-Phase Green. The controller mode and pertinent link data completes the display.

In addition to the display functions performed by Routine K, two Failure Table Updating functions are also performed: (1) Add, and (2) Failure Acknowledge/Failure Repair.

The Add portion of the routine is entered whenever a failure is identified by one of the other operational routines. The routine is entered with the number of the failed component and a code designating the nature of the failure, whether controller, detector, or communications. The Add function adds the component, along with present time, to the Failure Status table and increments the appropriate System Status failure list. The Audible Alarm and the appropriate warning light are turned on to alert the operator.

The Failure Acknowledge/Failure Repair portion of the routine is entered from the Manual Control Panel Processing Routine with the number of the equipment and its type. The table of failures is searched to locate the component in question. If it is not found, a Failure Error Flag (FLRFL) is set. If it is found, the appropriate code is added to the display table. If the Failure Repair function is required, the component is removed from the table and other components moved, where required, to close the gap in the table. The appropriate System Status failure list is decremented, the Audible Alarm is turned off, and the appropriate warning light is extinguished. Control is then returned to the Manual Control Panel Processing Routine.

PAGE DESCRIPTION: INTERSECTION STATUS
DISPLAY CODE : 5

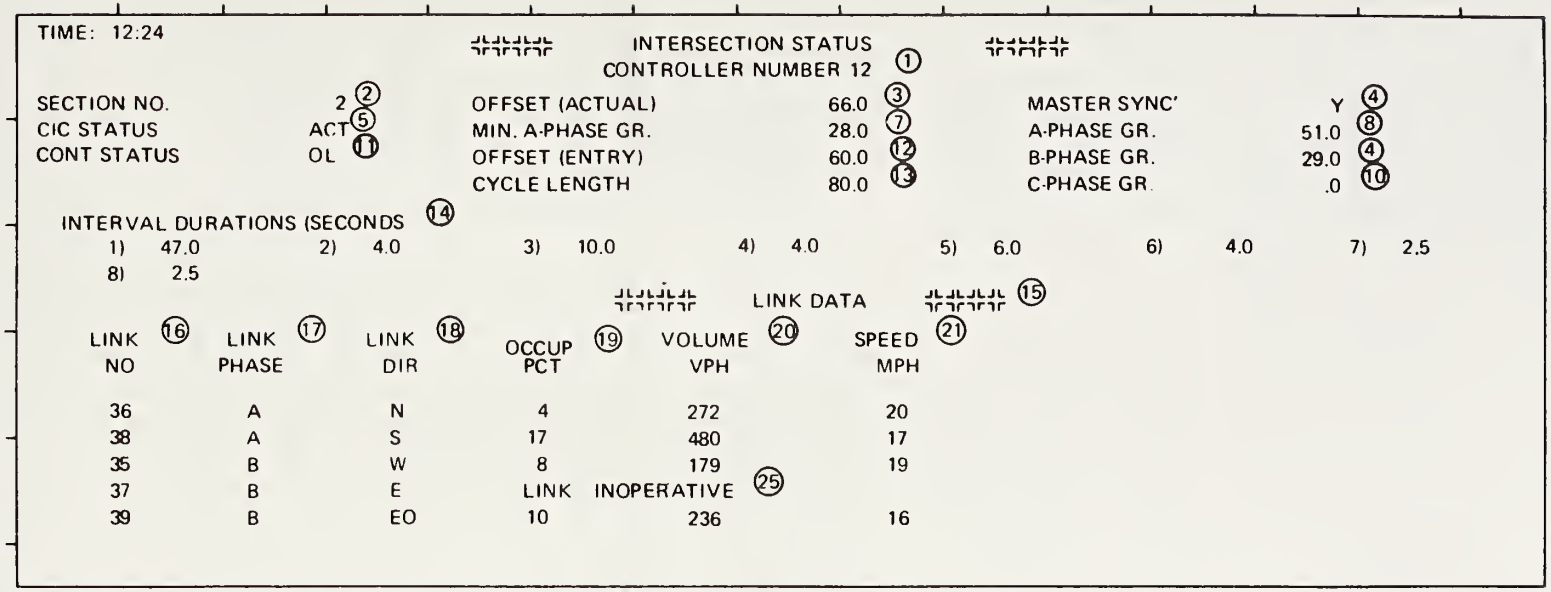

TIME: 12:24
INTERSECTION STATUS
CONTROLLER NUMBER 12 (1)
SECTION NO. 2 (2)
CIC STATUS ACT (5)
CONT STATUS OL (11)
OFFSET (ACTUAL) 66.0 (3)
MIN. A-PHASE GR. 28.0 (7)
OFFSET (ENTRY) 60.0 (12)
CYCLE LENGTH 80.0 (13)
MASTER SYNC' Y (4)
A-PHASE GR. 51.0 (8)
B-PHASE GR. 29.0 (4)
C-PHASE GR. .0 (10)
INTERVAL DURATIONS (SECONDS (14)
1) 47.0 2) 4.0 3) 10.0 4) 4.0 5) 6.0 6) 4.0 7) 2.5
8) 2.5
LINK DATA (15)
LINK NO (16)
LINK PHASE (17)
LINK DIR (18)
OCCUP PCT (19)
VOLUME VPH (20)
SPEED MPH (21)
36 A N 4 272 20
38 A S 17 480 17
35 B W 8 179 19
37 B E LINK INOPERATIVE (25)
39 B EO 10 236 16

Figure 15. Intersection Status Format

(1) CONTROLLER NUMBER (ITRNM)
LEGEND ABBREVIATION: I

(2) SECTION NUMBER (CNSEC(I))

(3) ACTUAL OFFSET (CUROF(I))

(4) MASTER SYNC - SET TO "Y" IF BACKGROUND CYCLE CORRESPONDING TO CONTROLLERS' CYCLE LENGTH IS SYNCHRONIZED WITH COMPUTER CLOCK.
CYCLC(I) OF KCTF=1.
OTHERWISE SET TO "N"

(5) C.I.C. STATUS:

STATUS	IF BIT I OF:
REL	CICSF = 0
INH	CICSF = 1, CICEF = 0
ACT	CICEF = 1, CICTF = 0
THLD	CICTF = 1
NI	CICSY=0

(7) MINIMUM A-PHASE GREEN DURATION: GGGG(4*I)

(8) A-PHASE GREEN DURATION
SSSS(4*I)+INTDU(K)
WHERE K=16*I+VRINT(4*I)

(9) B-PHASE GREEN DURATION
SSSS(4*I+1)+INTDU(K)
WHERE K=16*I+VRINT(4*I+1)

(10) C-PHASE GREEN DURATION
SSSS(4*I+2)+INTDU(K)
K=16*I+VRINT(4*I+2)

(11) CONTROLLER STATUS:

STATUS	IF BIT I, OF:
STBY	HOLD = 0
OL	HOLD = 1
FAIL	CMALF = 1

(12) ENTRY OFFSET. (ENOFF(I))

(13) CYCLE LENGTH KCL(K)
WHERE K = CYCLC (I)

(14) INTERVAL DURATIONS:
INTDU(16•I + K) WHERE K RANGES FROM 0 TO A MAX OF 16. LAST INTERVAL IS DETERMINED BY A DURATION OF 0 IF LESS THAN 16 INTERVALS

(15) LINK DATA HEADER:
DISPLAYED AS SHOWN IN NORMAL OPERATIONS. IF CONTROLLER IS IN A TRANSITIONAL CYCLE, (MI (I) ≠ 0) HEADER IS REPLACED BY "CONTROLLER IN TRANSITION" AND THE LOWER SECTION OF THE PAGE IS BLANKED OUT.

(16) LINK NUMBER: LINK NUMBERS FROM CNTLN. FIRST LINK IS POINTED TO BY LSI(I) AND THE TERMINAL LINK NUMBER IS INDICATED BY THE NEXT SUCCEEDING POSITIVE VALUE OF LSI. IF LSI(I) = -1, CONTROLLER HAS NO LINKS, AND THE MESSAGE "NOT INSTRUMENTED" IS OUTPUTTED.
LEGEND ABBREVIATION: L

(17) LINK PHASE: (LNKPT(L) OR LINKPH(L))
CODES ARE:
0,1 = A
2, 3 = B
4 = C
6 = D

(18) LINK DIRECTION: (LINKDI(L))
CODES ARE:
0 = N = NORTH
1 = S = SOUTH
2 = E = EAST
3 = W = WEST
4 = NE = NORTHEAST
5 = NW = NORTHWEST
6 = SE = SOUTHEAST
7 = SW = SOUTHWEST
8 = EO = EAST OUTBOUND

(19) LINK OCCUPANCY (AHCC(L)•100)

(20) LINK VOLUME = (VOL(L))

(21) LINK SPEED: (SBAR(L))

(25) MESSAGE OUTPUT WHEN A DETECTOR FAILURE ON THE LINK HAS OCCURRED

Figure 15. Intersection Status Format (Concluded)

The CRT Control and Data Formatting Routine comprises three separate subprograms. Routine K proper generates a buffer of data for the specified status display and causes that buffer to be output to the appropriate CRT. Subroutines KFMT and KFTU update the Failure Table whose contents may be presented by the Failure Status Display.

Routine K is scheduled by the Manual Control Panel Routine (M) as a result of an operator status display request, by the Executive Routine (A), once per 25 seconds for updating current displays, and by the Start-Up Routine (Y) for displaying initial System Status. The Level 3 executive routine will then enter Routine K whenever there are no other higher priority Level 3 tasks to be performed.

On the other hand, Subroutine KFMT (Acknowledge/Repair) is entered directly by its calling program, Routine M; KFTU is entered by scheduling Routine K and setting flags to tell Routine K that there are failures to be added to the failure table.

Both CRT's are updated each time a display request is made, unless an error condition exists on one of CRT lines. CRT 1 is updated first.

Routine K determines which display pages have been requested by examining the CRT Display Code (global variables CRTD1 or CRTD2). Display Code values of 1, 2, 3, 4, and 5, correspond respectively to Failure Status, System Status, Controller Status, Detector Status, and Intersection Status. Routine K branches to the appropriate program segment to obtain the data to be displayed, to format it, and to enter it in the output buffer for the selected CRT.

Utility subroutines are used to convert and format display data. For each display type, Routine K first initializes the buffer and generates a "boilerplate" display containing fixed formats, column headings, etc. It then

converts the variable display data and enters them into the output buffer. All CRT characters are displayed in a protected mode to assure non-interference from the CRT keyboard.

After completing the output buffer for the CRT, Routine K stores the number of characters to be output from the buffer, sets the Output Channel Active Flag for the selected CRT and triggers the Level 4 interrupt (X'68'). The actual character-by-character transmission to the CRT is initiated by Routine CRTOUT. The transfer is accomplished using RBM supplied Character Oriented Communications (COC) software. The output is transmitted over standard XDS Sigma 5 TTY interface.

Array Formats -- The Failure Table (FLTAB) has a capacity of 200 entries. Each four-word entry has the format:

Word 1, Byte 0: Acknowledge status (0 for NO, 1 for YES)

Byte 1: Equipment type code (3 for controller, 4 for detector, 5 for communications)

Byte 2, 3: Equipment identification number (binary)

Word 2, Byte 0: b

Byte 1: h

Byte 2: h

Byte 3: m

EBCDIC characters for time (hour and minute) of failure.

Word 3, Byte 0: m

Byte 1: b

	Byte 2:	M	
	Byte 3:	M	EBCDIC characters for abbreviated month
Word 4,	Byte 0:	M	
	Byte 1:	b	
	Byte 2:	D	EBCDIC characters for date
	Byte 3:	D	

Note that the EBCDIC character string for the time and date of the failure can be obtained using the RBM TIME CAL and stored in the Failure Table in a suitable format.

The Sectional Controller Failure Count Array (SECFC) has a word capacity equal to the number of sections in the traffic control system (N_s). Each one-word entry contains, in binary, the number of failed controllers contained in the section.

SECFC(1): Number of failed controllers in Section 1

SECFC(2): Number of failed controllers in Section 2

.

.

.

SECFC(N_s): Number of failed controllers in Section N_s

The Sectional Detector Failure Count Array (SCDFC) has a word capacity equal to the number of sections in the traffic control system (N_s). Each one-word entry contains, in binary, the number of failed detectors contained in this section.

SCDFC(1): Number of failed detectors in Section 1

SCDFC(2): Number of failed detectors in Section 2

.

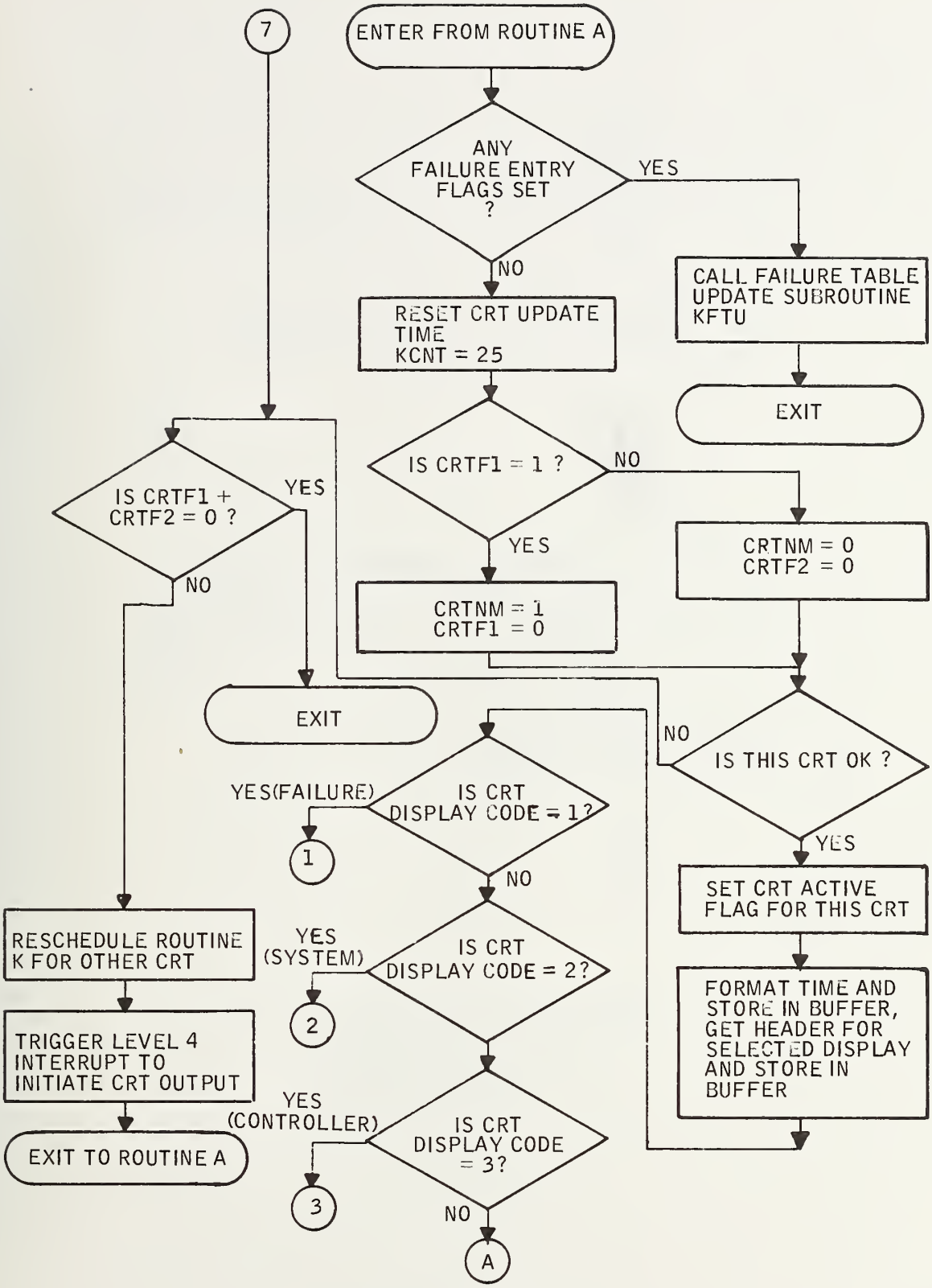
.

.

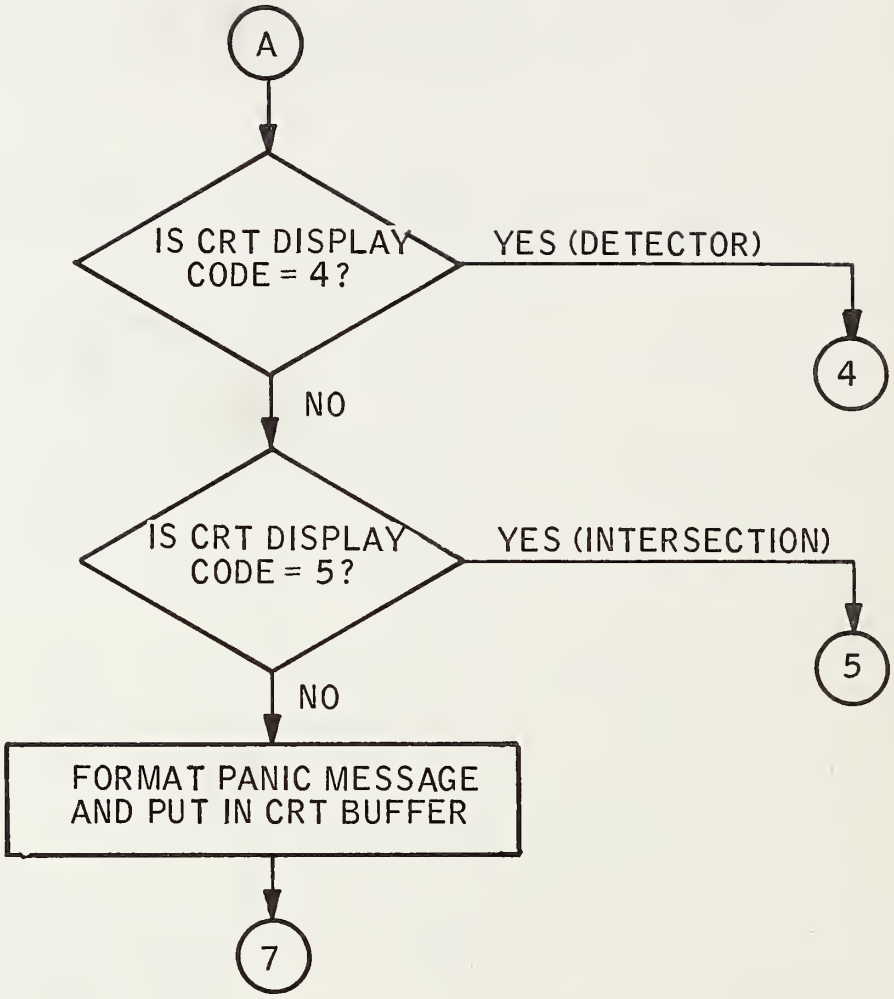
SCDFC(N_S): Number of failed detectors in Section N_S.

2.6.38.5 Listing

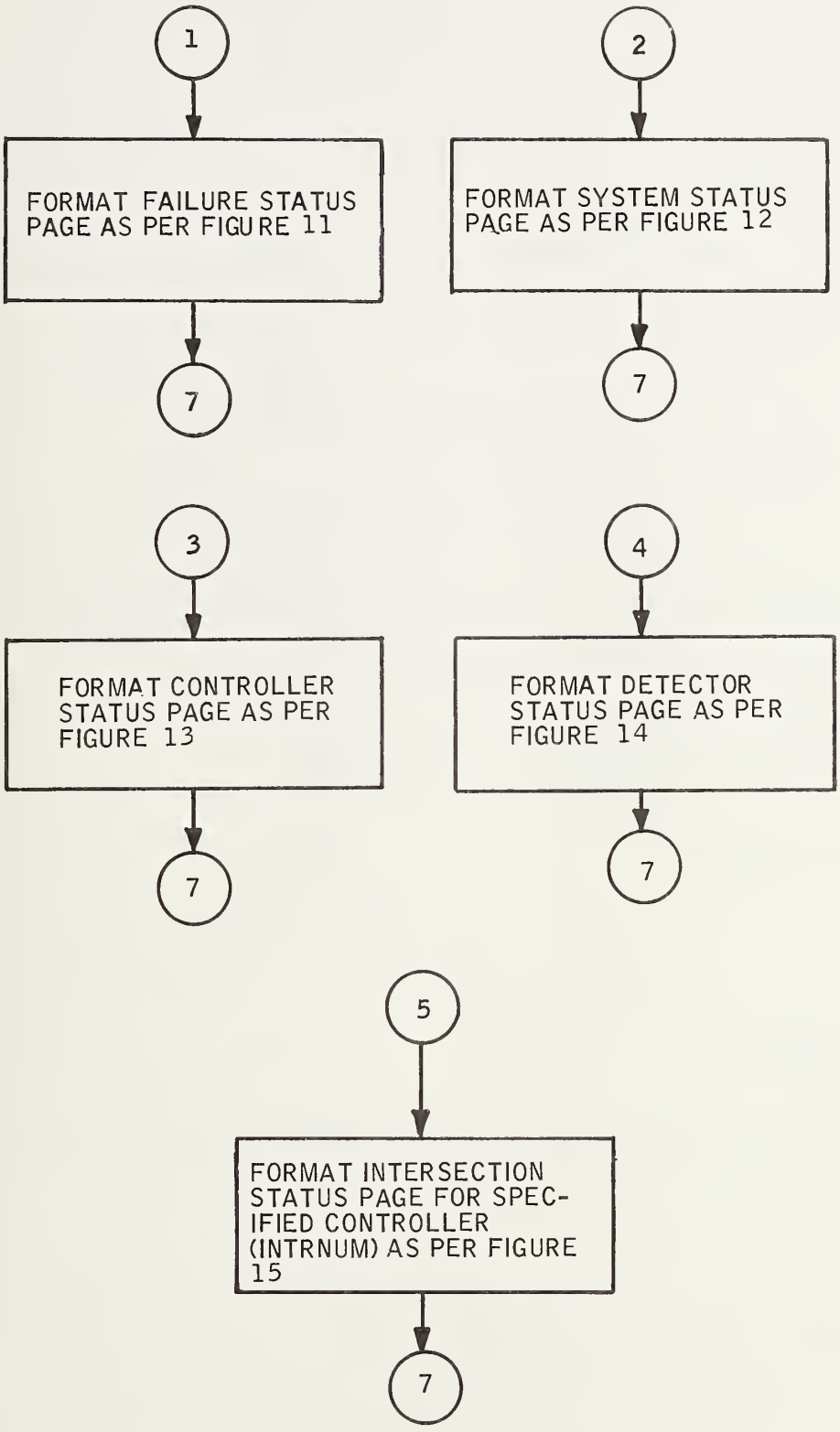
See Volume III, 2GCF Routine Listings.


7
ENTER FROM ROUTINE A
ANY FAILURE ENTRY FLAGS SET ?
YES
NO
CALL FAILURE TABLE UPDATE SUBROUTINE KFTU
EXIT
RESET CRT UPDATE TIME KCNT = 25
IS CRTF1 = 1 ?
NO
YES
CRTNM = 0 CRTF2 = 0
CRTNM = 1 CRTF1 = 0
IS CRTF1 + CRTF2 = 0 ?
YES
NO
EXIT
NO
IS THIS CRT OK ?
YES
SET CRT ACTIVE FLAG FOR THIS CRT
FORMAT TIME AND STORE IN BUFFER, GET HEADER FOR SELECTED DISPLAY AND STORE IN BUFFER
YES(FAILURE)
IS CRT DISPLAY CODE = 1?
1
NO
RESCHEDULE ROUTINE K FOR OTHER CRT
YES (SYSTEM)
IS CRT DISPLAY CODE = 2?
2
TRIGGER LEVEL 4 INTERRUPT TO INITIATE CRT OUTPUT
YES (CONTROLLER)
IS CRT DISPLAY CODE = 3?
EXIT TO ROUTINE A
3
NO
A

Routine K



Routine K (Continued)



Routine K (Concluded)

2.6.39 SUBROUTINE CIC

2.6.39.1 Purpose

Subroutine CIC counts the number of active critical intersection controllers.

2.6.39.2 Relationship

This subroutine is called from routines K and STAT by:

```
CALL CIC (ICEF, IR4, CICCT)
```

where:

- ICEF = word index for bit interleaved array (CICEF)
- IR4 = word index for bit array (CICSC)
- CICCT = number of CICs to be returned

This subroutine calls GETBI.

2.6.39.3 Assumption

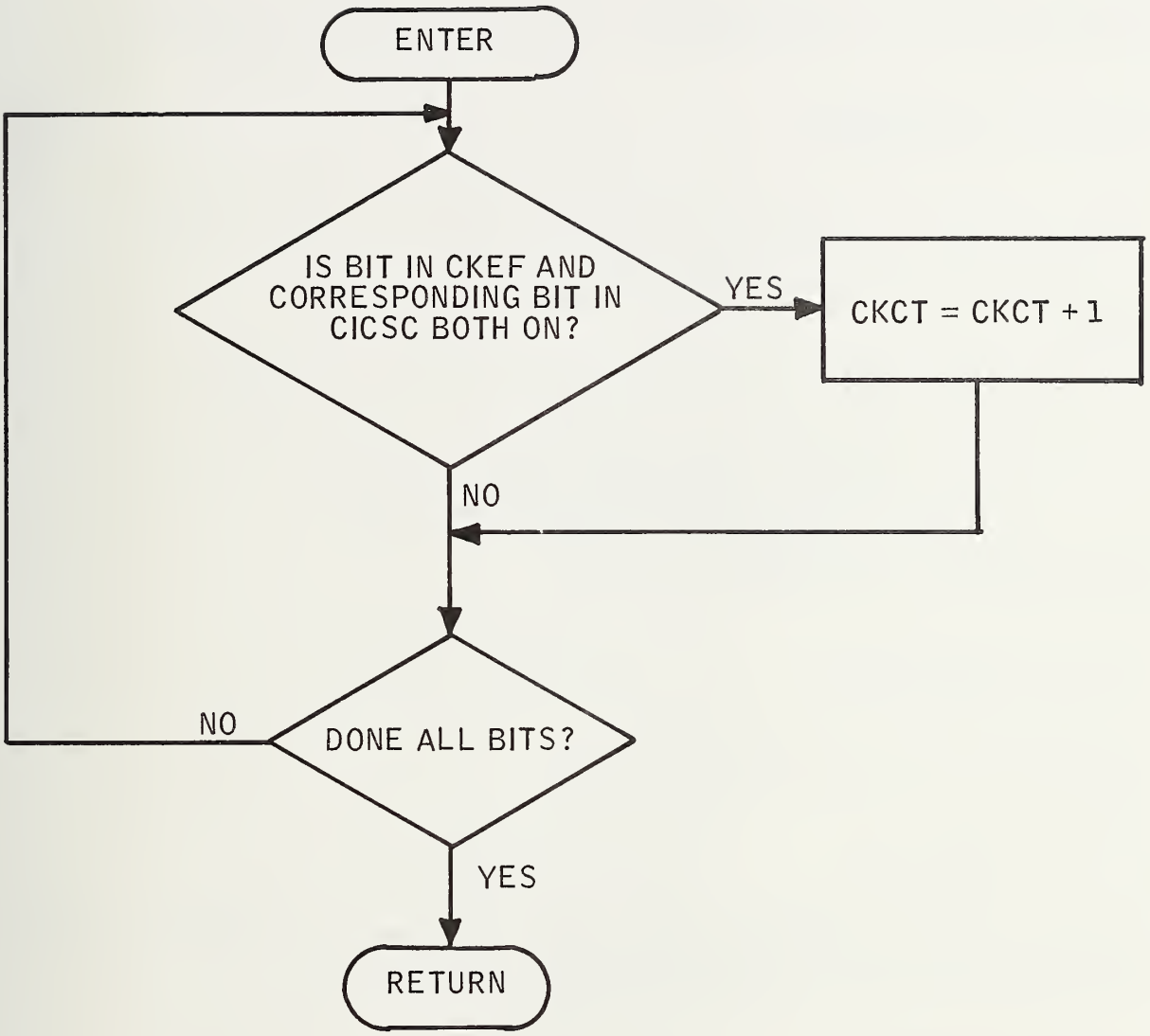
None.

2.6.39.4 Approach

Subroutine CIC examines corresponding bits in the CICEF and CICSC arrays and if they are both set, increments CICCT.

2.6.39.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine CIC

2.6.40 SUBROUTINE CNVT

2.6.40.1 Purpose

Subroutine CNVT converts EBCDIC characters to ASCII characters.

2.6.40.2 Relationship

This subroutine is called from routines GREEN, K, and SCODE by:

CALL CNVT (ADDR, NUM, BSI)

where:

- ADDR = address of character string
- NUM = number of characters to be converted
- BSI = CRT output buffer (CRTB1) store index

This subroutine calls GETBY, PTBY.

2.6.40.3 Assumption

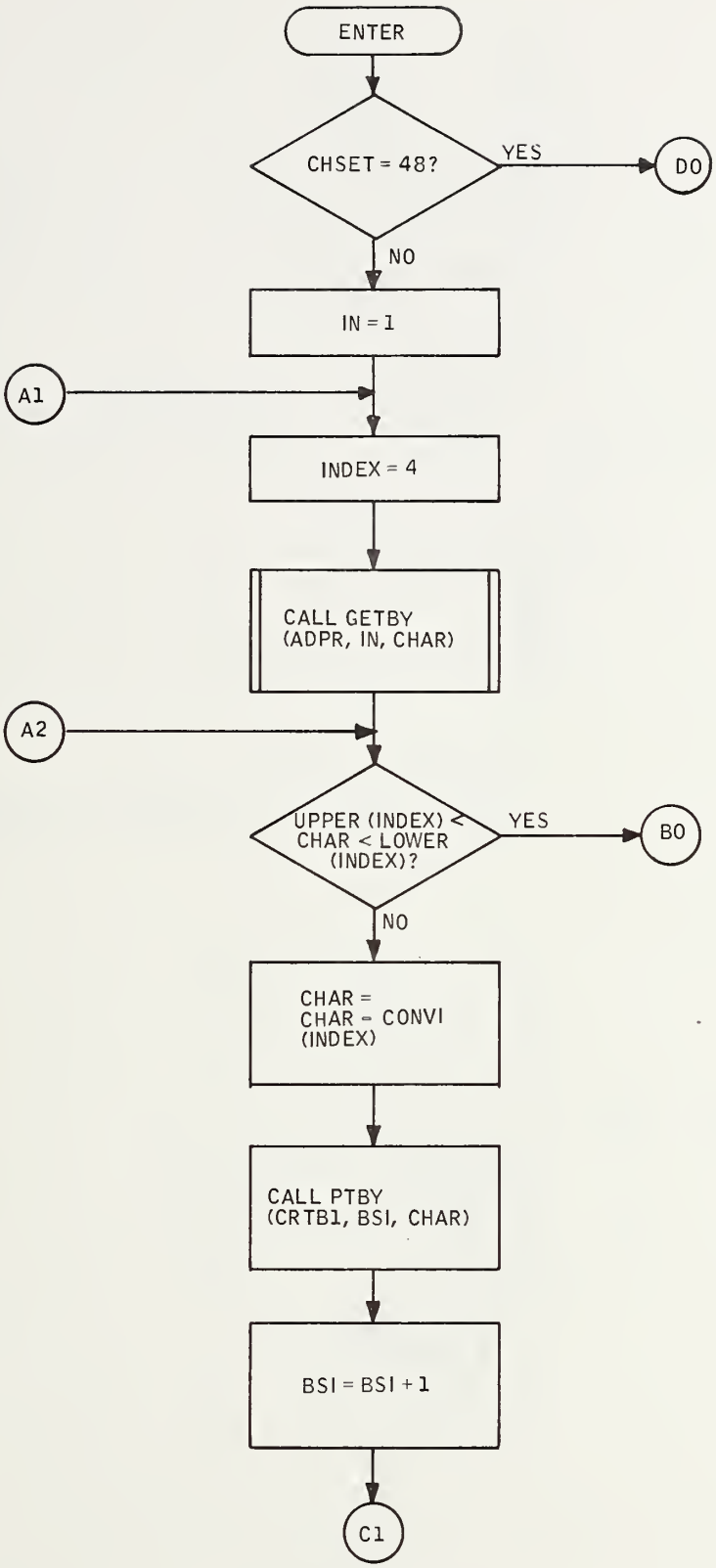
System uses EBCDIC character codes.

2.6.40.4 Approach

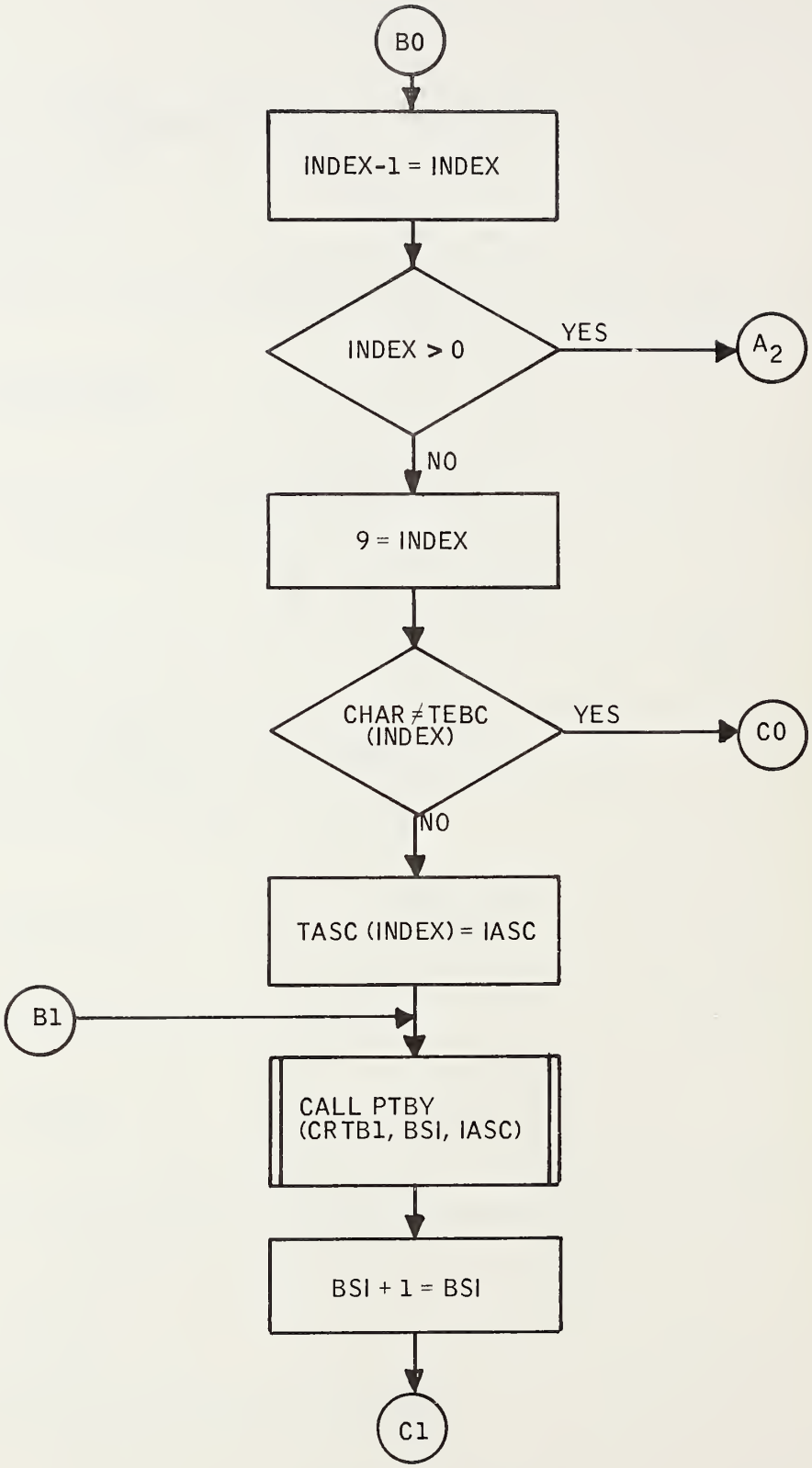
Subroutine CNVT examines the NUM characters stored in ADDR, converts them to ASCII format, and stores them in the BSI array.

2.6.40.5 Listing

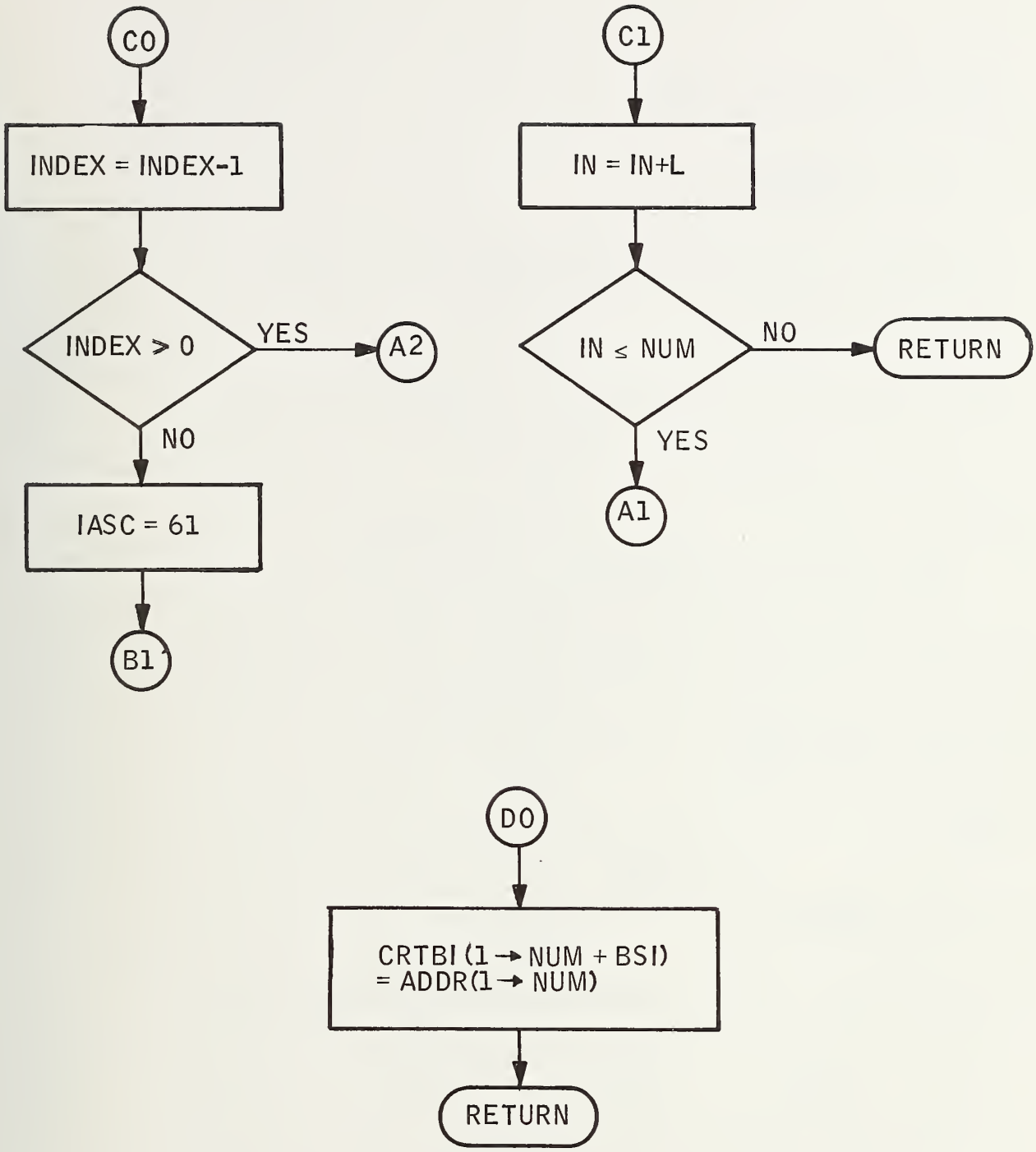
See Volume III, 2GCF Routine Listings.



Subroutine CNVT



Subroutine CNVT (Continued)



Subroutine CNVT (Concluded)

2.6.41 SUBROUTINE CRLF

2.6.41.1 Purpose

Subroutine CRLF spaces the CRT cursor down (N) lines.

2.6.41.2 Relationship

This subroutine is called from subroutines GREEN and K by:

CALL CRLF (BSI, N)

where:

BSI = CRT buffer store index

N = number of lines to space down on CRT

This subroutine calls PTBY.

2.6.41.3 Assumption

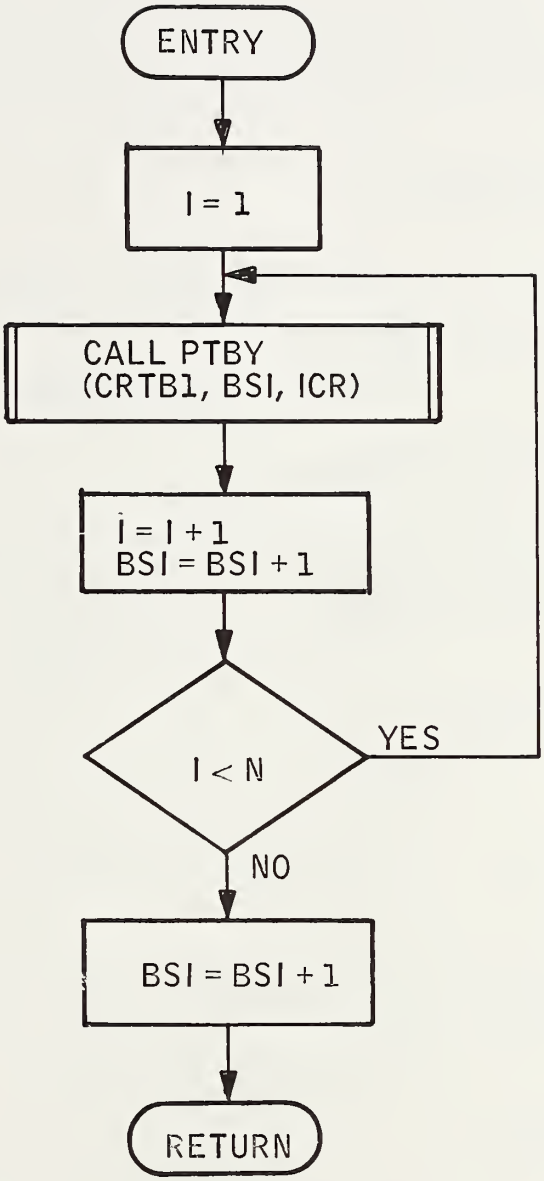
None.

2.6.41.4 Approach

Subroutine CRLF stores in carriage returns in the BSI array.

2.6.41.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine CRLF

2.6.42 SUBROUTINE DCMAL

2.6.42 Purpose

Subroutine DCMAL converts a number scaled B1 to decimal scaled 10, inserts a decimal point and stores it in the CRT buffer.

2.6.42.2 Relationship

This subroutine is called from subroutine GREEN by:

CALL DCMAL (BSI, NUMB)

where:

BSI = CRT buffer store index

NUMB = number scaled B1 to be converted to F4.1 format

This subroutine calls DISNM.

2.6.42.3 Assumption

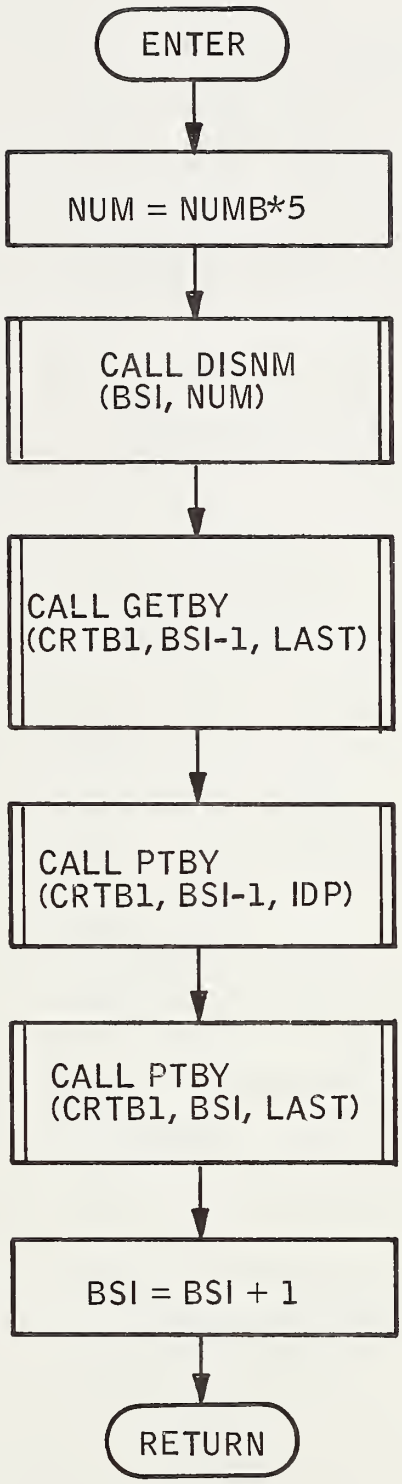
None.

2.6.42.4 Approach

Subroutine DCMAL converts the scaled integer NUMB to F4.1 format and stores it in the BSI array.

2.6.42.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine DCMAL

2.6.43 SUBROUTINE DISIN

2.6.43.1 Purpose

Subroutine DISIN initializes the CRT buffer.

2.6.43.2 Relationship

This subroutine is called from Routine K by:

CALL DISIN (BPI)

where:

BPI = byte index for CRT buffer (CRTB1)

This subroutine calls PTBY.

2.6.43.3 Assumption

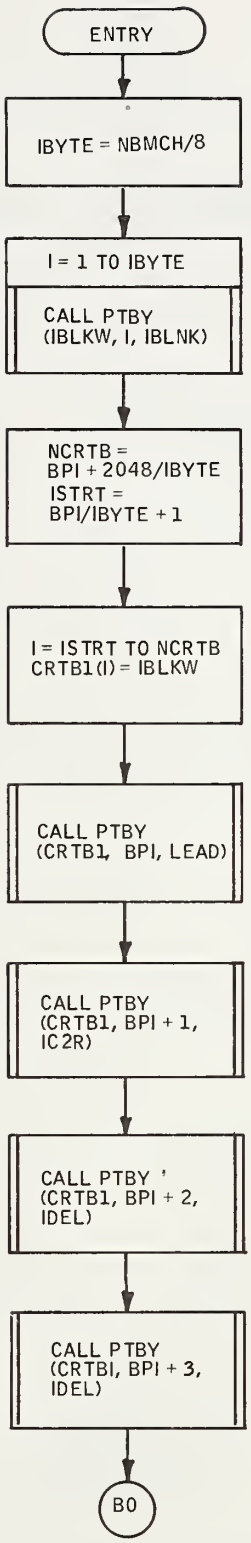
None.

2.6.43.4 Approach

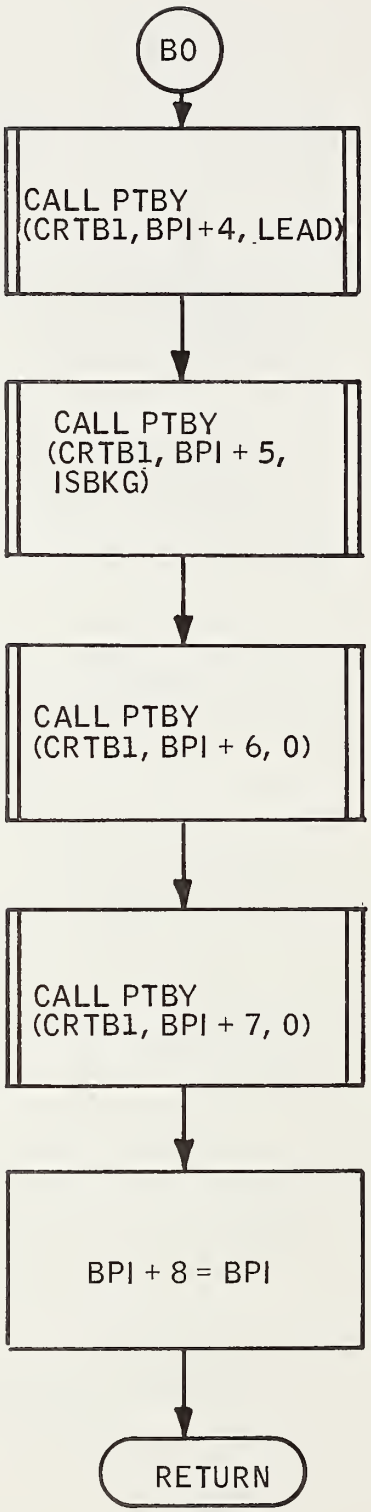
DISIN fills the CRT buffer with blanks, then places the first two words in the CRT buffer.

2.6.43.5 Listing

See Volume III, 2GCF Routine Listings.


ENTRY
IBYTE = NBMCH/8
I = 1 TO IBYTE
CALL PTBY (IBLKW, I, IBLNK)
NCRTB = BPI + 2048/IBYTE
ISTRT = BPI/IBYTE + 1
I = ISTRT TO NCRTB
CRTB1(I) = IBLKW
CALL PTBY (CRTB1, BPI, LEAD)
CALL PTBY (CRTB1, BPI + 1, IC2R)
CALL PTBY (CRTB1, BPI + 2, IDEL)
CALL PTBY (CRTBI, BPI + 3, IDEL)
B0

Subroutine DISIN



Subroutine DISIN (Concluded)

2.6.44 SUBROUTINE DISNM

2.6.44.1 Purpose

Subroutine DISNM converts a binary number to ASCII and stores the results in the CRT buffer (CRTB1).

2.6.44.2 Relationship

This subroutine is called from routines DCMAL and K by:

CALL DISNM (BPI, NUMB)

where:

BPI = byte index of CRT buffer (CRTB1)

NUMB = the binary number to be converted.

This subroutine calls PTBY.

2.6.44.3 Assumption

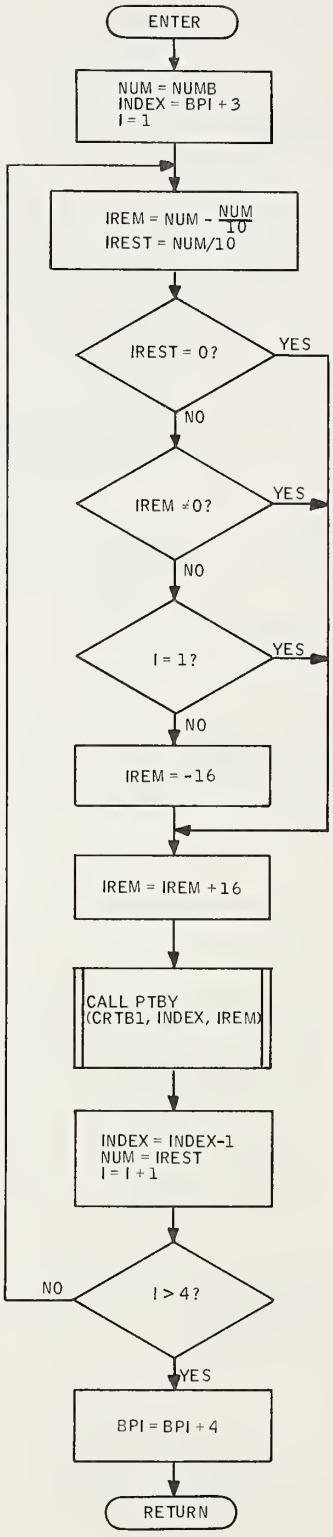
None.

2.6.44.4 Approach

DISNM isolates each binary digit of NUMB, converts it to ASCII by adding 48, and stores it in the CRT buffer.

2.6.44.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine DISNM

2.6.45 SUBROUTINE GREEN

2.6.45.1 Purpose

This routine stores desired phase label in CRT buffer.

2.6.45.2 Relationship

This subroutine is called from Routine K by::

```
CALL GREEN (BSI, INDEX, IPHAS)
```

where:

BSI = the CRT buffer

INDEX = index to SSSS and GGGG arrays

IPHAS = 1 A-phase green
= 2 B-phase green
= 3 C-phase green

This subroutine calls CNVT, GETBY, DCMAL, CRLF.

2.6.45.3 Assumption

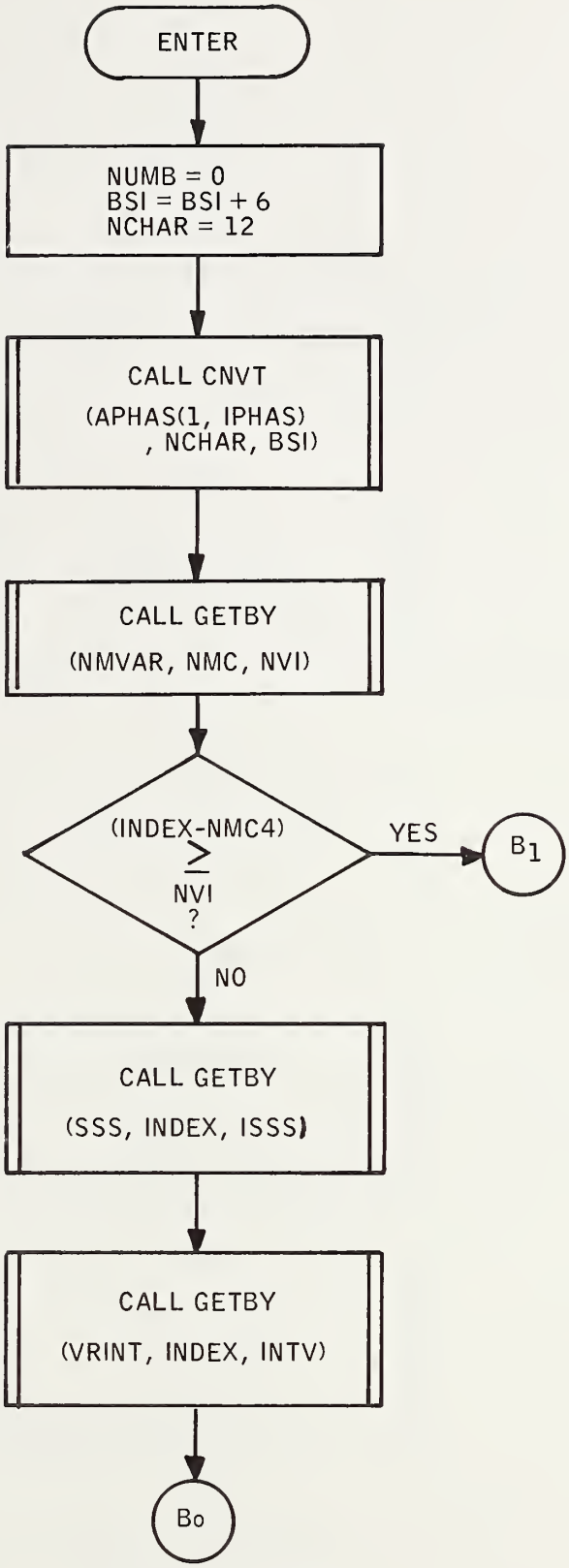
None.

2.6.45.4 Approach

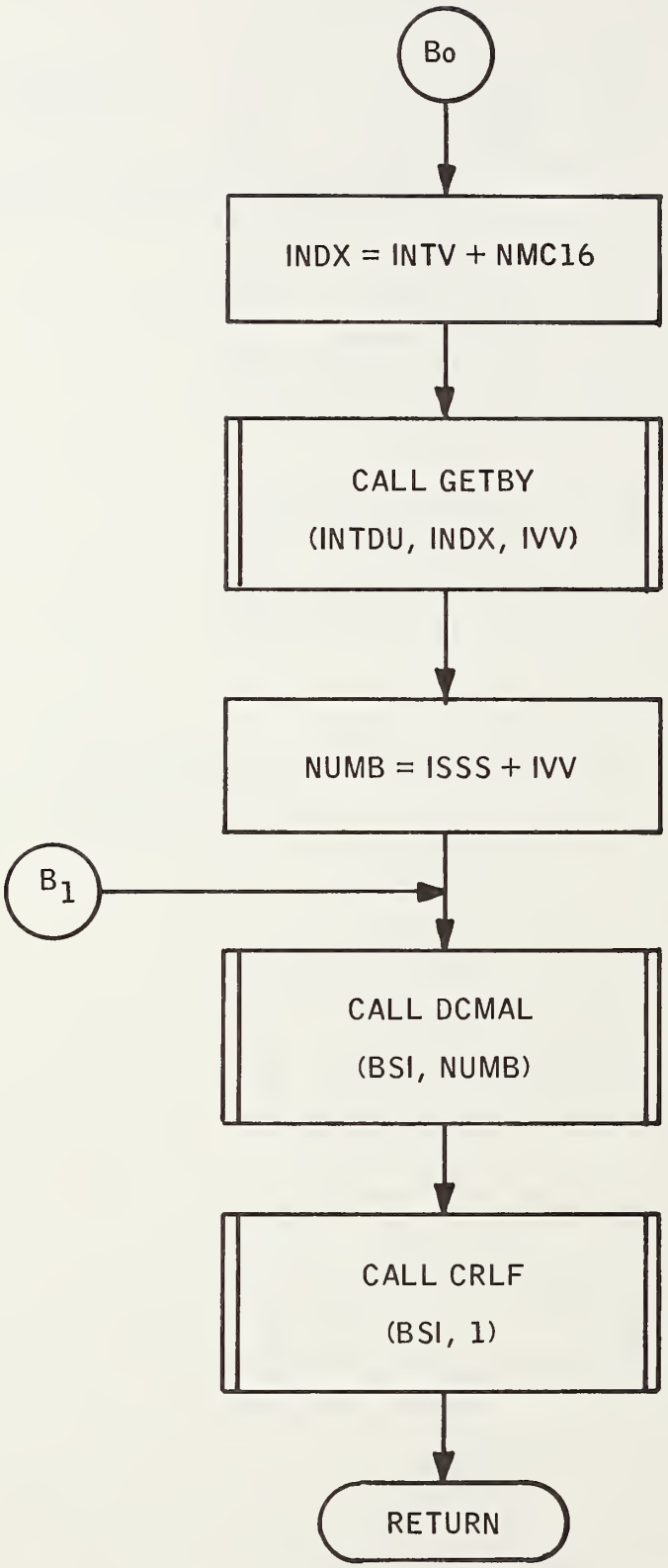
Subroutine GREEN calls on subroutine CNVT to convert the character string specified by IPHAS to ASCII code and store it in the CRT buffer. The phase duration is then converted to F4.1 format and stored in CRT buffer. Finally a carriage return is placed in the buffer and GREEN returns to the calling routine.

2.6.45.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine GREEN



Subroutine GREEN (Concluded)

2.6.46 SUBROUTINE KFTU

2.6.46.1 Purpose

This subroutine records failures in the fail table and Turn Failure Light and Alarm On.

2.6.46.2 Relationship

This subroutine is called from Routine K by:

```
CALL KFTU
```

This subroutine calls TODAY, HALF, PTBY, GETBY, INTRP, PTBI.

2.6.46.3 Assumption

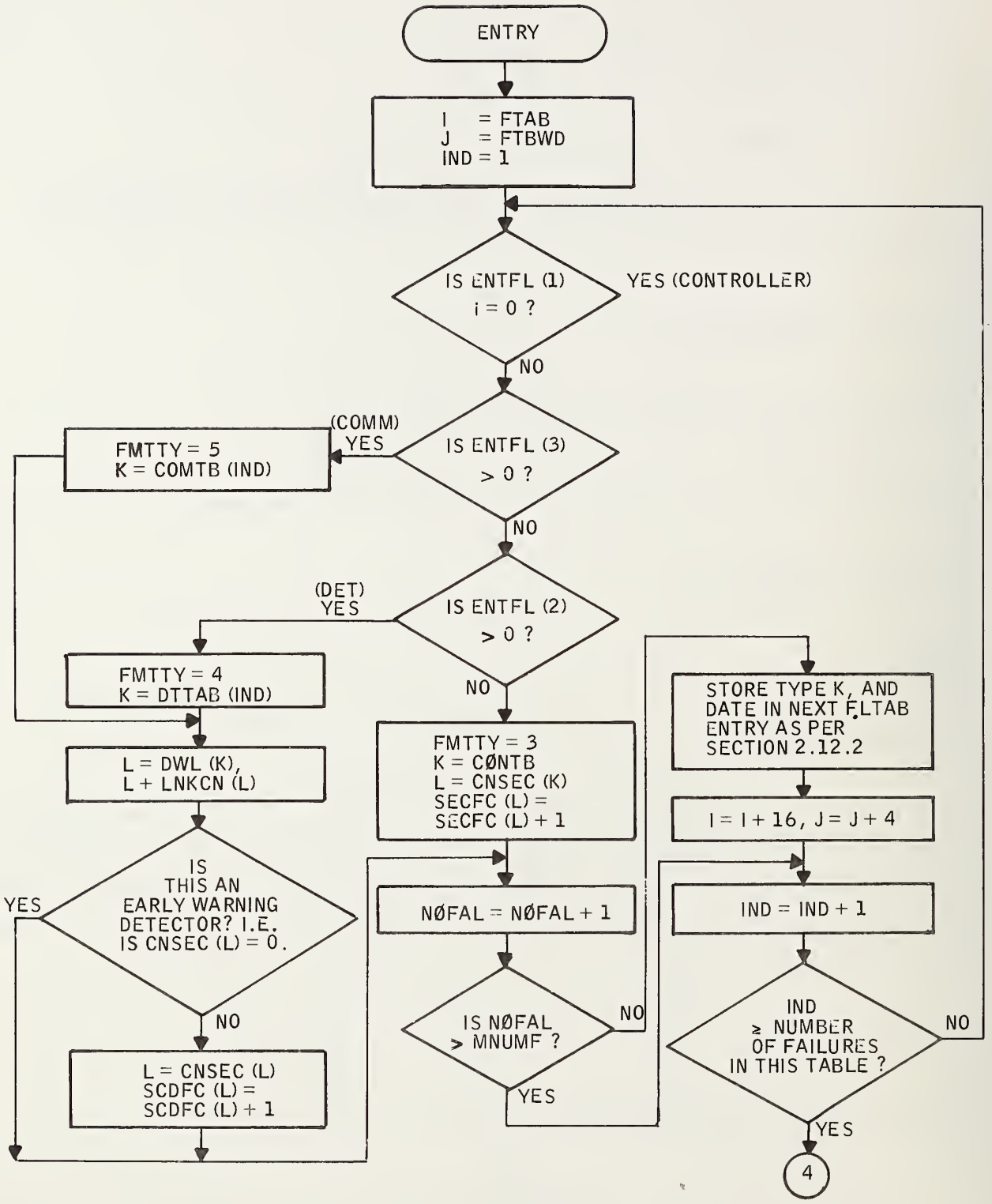
None.

2.6.46.4 Approach

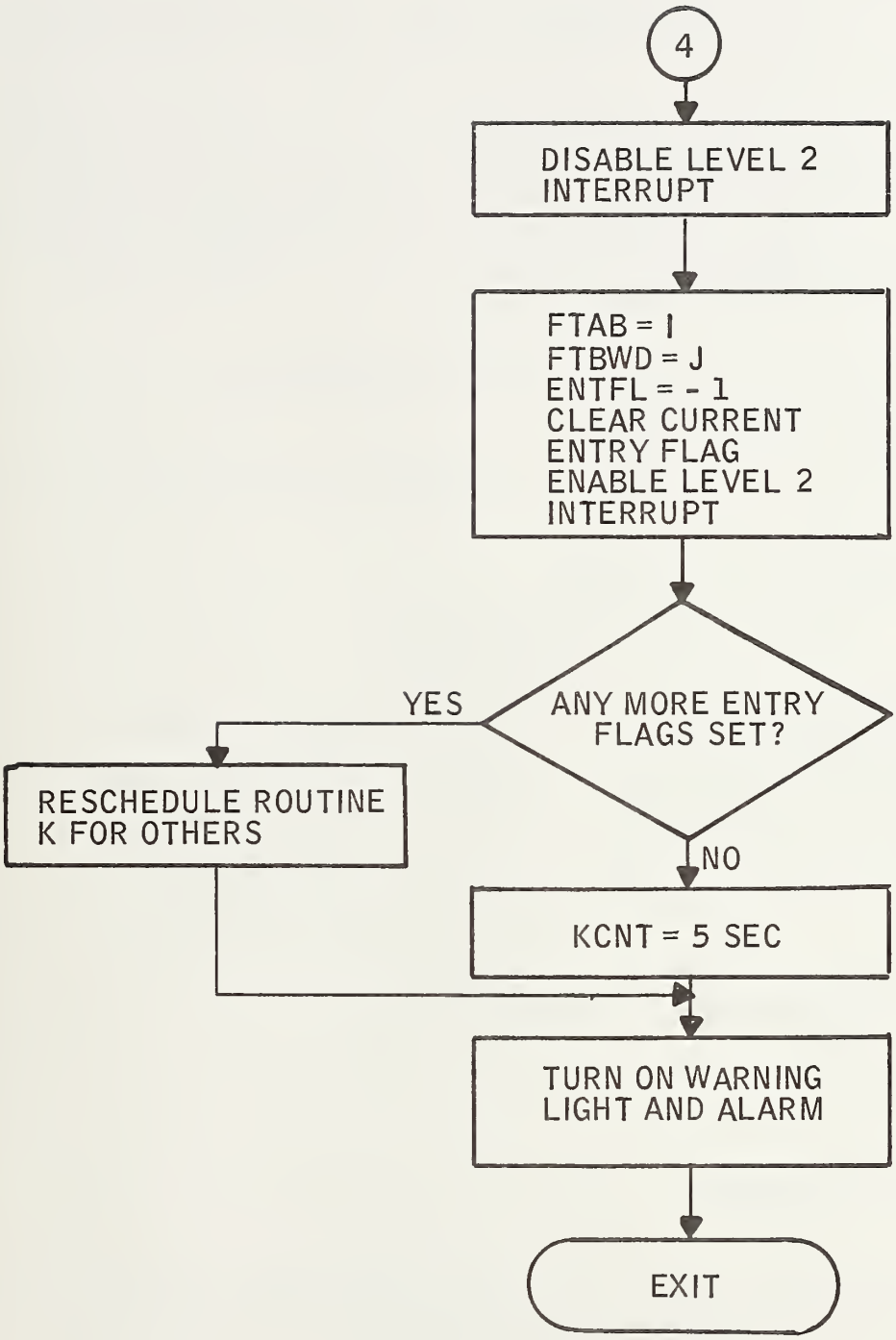
KFTU determines the current day and time. It then examines the failure entry flags and determines if there is room in the proper tables for recording the time and equipment number of failed devices. PTBI is called to set two bits, in order to activate the alarm and warning light. KFTU then returns to the calling subroutine.

2.6.46.5 Listing

See Volume III, 2GCF Routine Listings.


ENTRY
I = FTAB
J = FTBWD
IND = 1
IS ENTFL (1) i = 0 ?
YES (CONTROLLER)
NO
IS ENTFL (3) > 0 ?
(COMM) YES
FMTTY = 5
K = COMTB (IND)
NO
IS ENTFL (2) > 0 ?
(DET) YES
FMTTY = 4
K = DTTAB (IND)
NO
FMTTY = 3
K = CØNTB
L = CNSEC (K)
SECFC (L) = SECFC (L) + 1
L = DWL (K), L + LNKCN (L)
IS THIS AN EARLY WARNING DETECTOR? I.E. IS CNSEC (L) = 0.
YES
NO
L = CNSEC (L)
SCDFC (L) = SCDFC (L) + 1
NØFAL = NØFAL + 1
IS NØFAL > MNUMF ?
NO
YES
STORE TYPE K, AND DATE IN NEXT FLTAB ENTRY AS PER SECTION 2.12.2
I = I + 16, J = J + 4
IND = IND + 1
IND ≥ NUMBER OF FAILURES IN THIS TABLE ?
NO
YES
4

Subroutine KFTU



Subroutine KFTU (Concluded)

2.6.47 SUBROUTINE TODAY

2.6.47.1 Purpose

Subroutine TODAY gets the current time of day from the RBM.

2.6.47.2 Relationship

This subroutine is called from subroutine KFTU by:

CALL TODAY (TIMBF)

where:

TIMBF is the mnemonic:

TIMBF = Time of day (4 words)

h	h	:	m
m	o	m	o
n	o	d	d
'	'	y	y

where

hh is the hour
mm is the minute
mon is the month
dd is the day
yy is the year.

2.6.47.3 Assumption

None.

2.6.47.4 Approach

This subroutine is called only by Subroutine KFTU in Priority Level 3 and is therefore not required to be re-entrant.

The four words of time of day consist of EBCDIC code for.

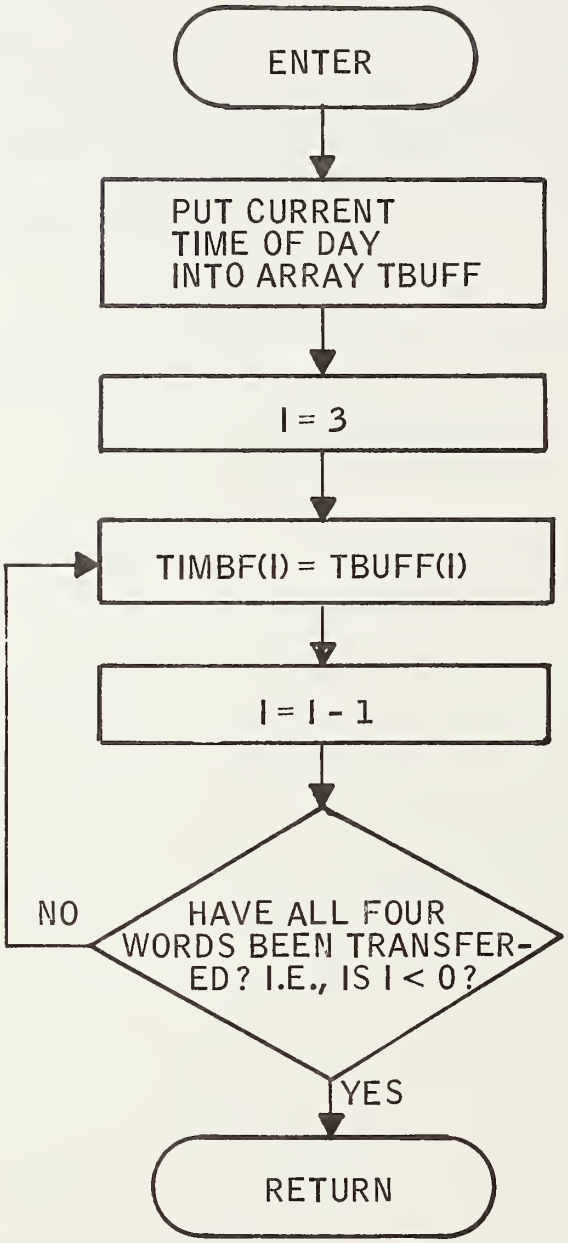
h	h	:	m
m		m	o
n		d	d
'	'	y	y

where

hh is the hour (o ≤ hh ≤ 23)
mm is the minute (o ≤ mm ≤ 59)
mon is the month (3 letters)
dd is the day (o ≤ dd ≤ 31)
yy is the year (oo ≤ yy ≤ 99).

2.6.47.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine TODAY

2.6.48 SUBROUTINE TRIG

2.6.48.1 Purpose

Subroutine TRIG triggers an interrupt that causes Routine A to schedule Subroutine CRTOUT of Priority Level 4.

2.6.48.2 Relationship

This subroutine is called from Routine K by:

```
CALL TRIG
```

2.6.48.3 Assumption

None.

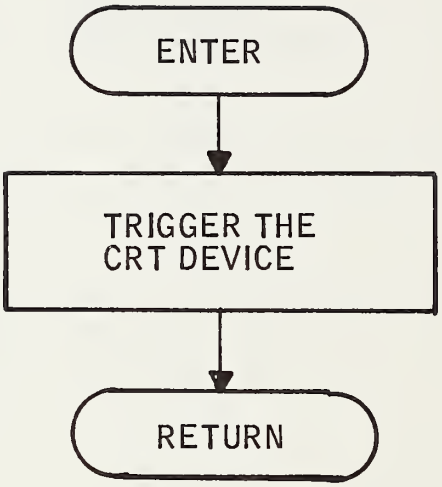
2.6.48.4 Approach

This subroutine is called from Routine K and is therefore not required to be re-entrant.

It calls on the Real-Time Batch Monitor (RBM) to trigger an interrupt.

2.6.48.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine TRIG

2.6.49 SUBROUTINE SCODE

2.6.49.1 Purpose

Subroutine SCODE stores the desired status code for the detectors and controllers in the CRT buffer.

2.6.49.2 Relationship

This subroutine is called from Routine K by:

CALL SCODE (BSI, ICHAR, IOUT, LINE, IRTRN)

where:

BSI = CRT buffer store index

ICHAR = Status code character (1 = S, 2 = F, 3 = C, 4 = I, 5 = D)

IOUT = Current number of items on this print line

LINE = Current line count

IRTRN = 0 More data to be output, continue processing upon returning to calling routine

= 1 Last data, go to output wrap-up in calling routine upon returning.

This subroutine calls PTBY, SETCR, CNVT.

2.6.49.3 Assumption

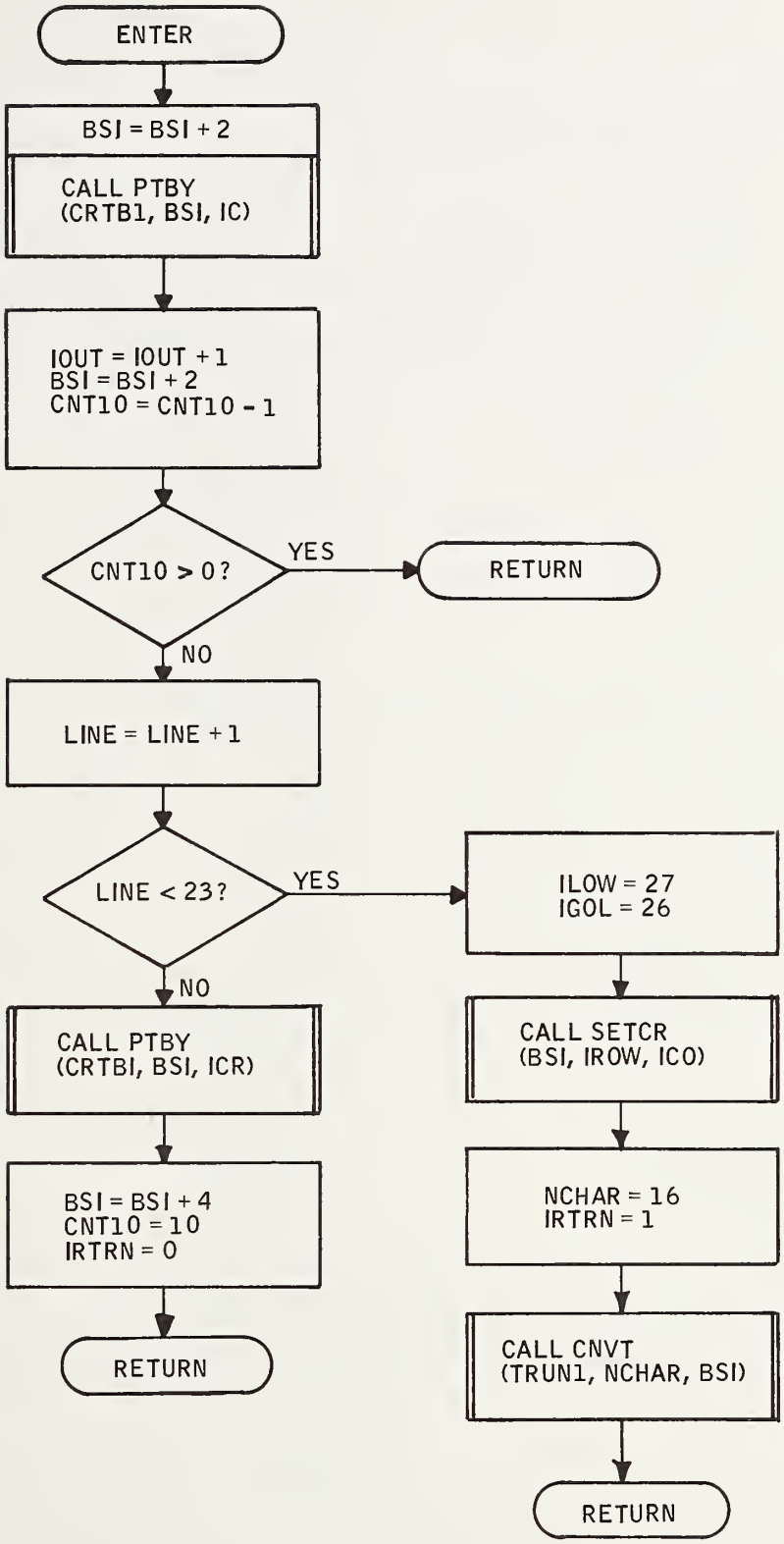
None.

2.6.49.4 Approach

SCODE stores the desired status code for the detectors and controllers in the CRT buffer. Provisions are included to limit output to one page.

2.6.49.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine SCODE

2.6.50 SUBROUTINE SETCR

2.6.50.1 Purpose

Subroutine SETCR inserts cursor control commands in the CRT buffer.

2.6.50.2 Relationship

This subroutine is called from subroutine SCODE by:

CALL SETCR (BPI, IROW, ICOL)

where:

BPI = CRT buffer pointer index

IROW = Binary row number

ICOL = Binary column number.

This subroutine calls PTBY.

2.6.50.3 Assumption

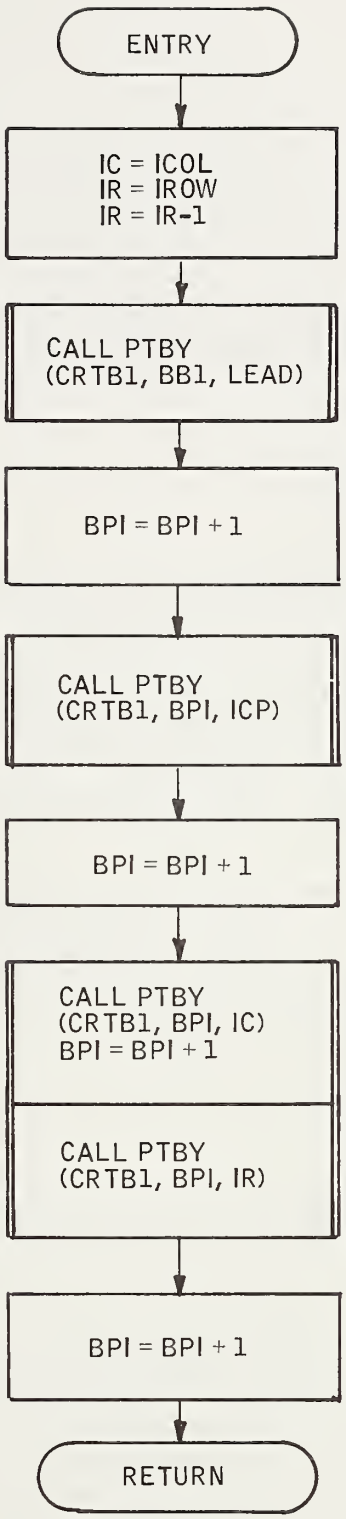
None.

2.6.50.4 Approach

Subroutine SETCR makes repeated calls to subroutine PTBY to store a lead-in character, the cursor position command, and the row (IROW) and column (ICOL) numbers in the CRT buffer. SETCR then returns to the calling routine.

2.6.50.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine SETCR

2.6.51 ROUTINE M

2.6.51.1 Purpose

Routine M evaluates the control panel inputs for reasonableness and stores the data and flags required by other routines to perform the requested operations.

2.6.51.2 Relationship

This routine is entered at half-second intervals whenever time remains after the completion of higher priority routines. It is called by the Executive Routine, Routine A, as part of the Level 3 Priority functions. The routine calls Subroutine MSUB to pack and unpack data from the control panel output and input words, respectively. Subroutines HFMT and KFMT are also called.

2.6.51.3 Assumption

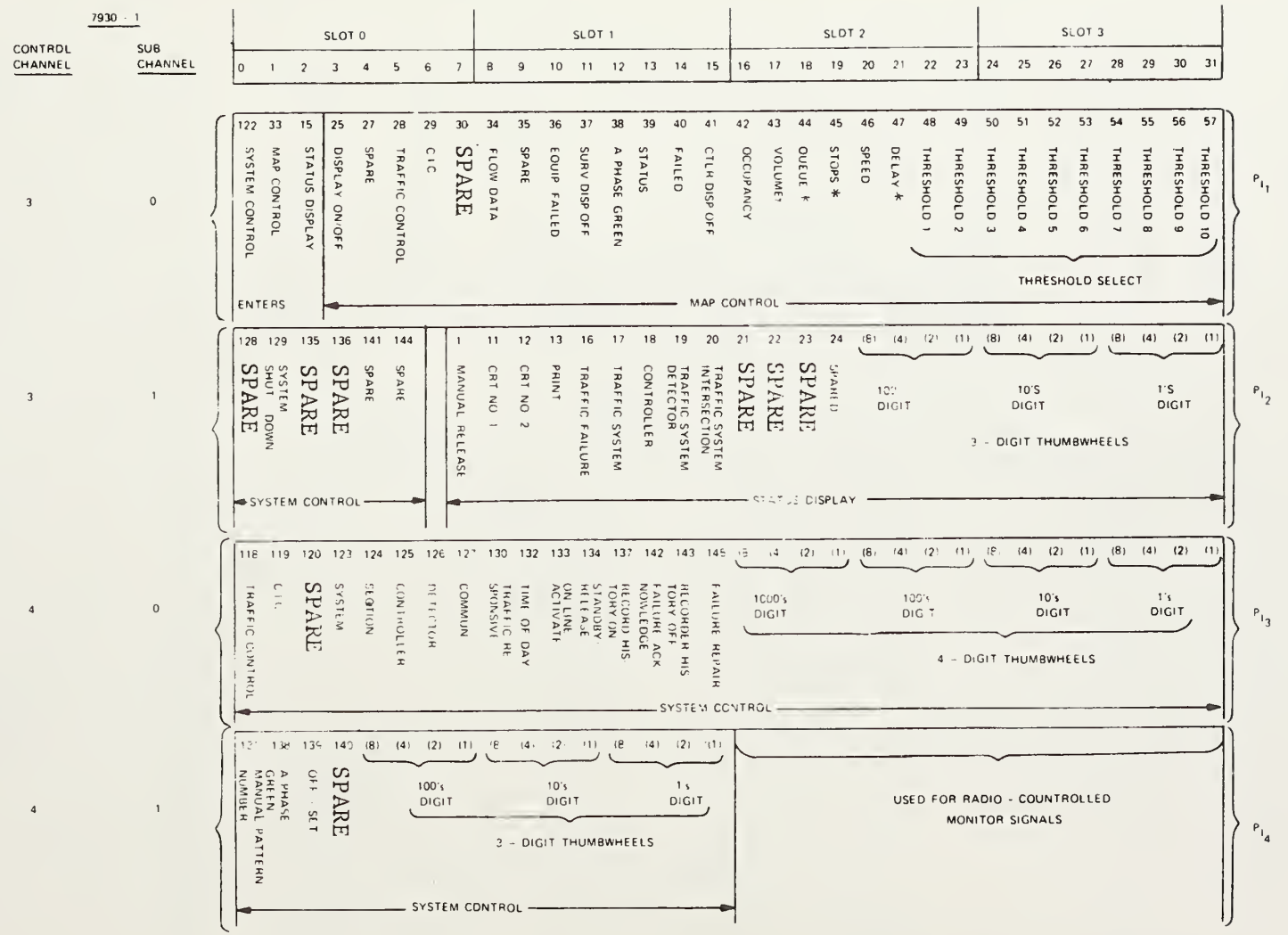
The Manual Control Panel is operational.

2.6.51.4 Approach

(Figures 16 and 17 illustrate the Control Panel Output and Input Bit Assignments, respectively.)

Upon entry, Routine M resets the first five bits of the control panel output word (CPNOT). A check is made of the PRINTOUT SUPPRESS button (CPNIN, WORD2, BIT 10) and if it is set, Routine M sets the 15-minute report flag (PRTFL). If it is not set Routine M resets the 15-minute report flag. Next a check is performed to see if any of the enter bits (CPNIN, WORD1, BITS 0-2) are set. If none are set, Routine M exits.

Figure 16. Control Panel Output Bit Assignments



*INACTIVE

Figure 17. Control Panel Input Bit Assignments

System Enter -- If the system enter bit (CPNIN, WORD1, BIT 0) is set, the system ready bit of the control panel output word (CPNOT, BIT 0) is set. The shutdown flag (SHTFL) is checked. If it is set, the error exit is taken. This prevents system entries during shutdown. At the error exit the system error bit of the control panel output word (CPNOT, BIT 3) is set. If the shutdown flag is not set, a check is made to see if this is a shutdown request (CPNIN, WORD2, BIT 1). If it is, the shutdown flag is set, Routine H is scheduled and Routine M exits. If it is not shutdown, the traffic control bit (CPNIN, WORD3, BIT 0) and CIC bit (CPNIN, WORD 3, BIT 1) are checked. If none are set, Routine M takes the error exit.

Traffic Control -- The system bit (CPNIN, WORD3, BIT 3), the section bit (CPNIN, WORD3, BIT 4), the controller bit (CPNIN, WORD3, BIT 5), the detector bit (CPNIN, WORD3, BIT 6), and the communications bit (CPNIN, WORD3, BIT 7) are checked. If none are set Routine M takes the error exit.

If the system bit is set, the on-line bit (CPNIN, WORD3, BIT 10) is checked. If it is set, the first start flag (FSTFL) is checked and if set Routine M takes the error exit. If the flag is not set, it is now set, the 15-minute section flag (FMSCF) and the 15-minute system flag (FMSYF) are set, and Routine W is scheduled. If the on-line bit is not set, FSTFL is checked to see if it is set. If it isn't, Routine M takes the error exit. If the flag is set, the traffic responsive bit (CPNIN, WORD3, BIT 8) is checked and if set the 15-minute section flag (FMSCF) is checked. If the flag is set, the wait bit of the control panel output word (CPNOT, BIT 5) is set and Routine M exits. If the flag is not set, the mode change desired flags (MCDF) are set for all sections and the desired mode flags (DMODE) are set to traffic responsive for all sections. If the traffic responsive bit is not set, the time of day bit (CPNIN, WORD3, BIT 9) is checked and if it is set the 15-minute section flag (FMECF) is checked. If the flag is set, the wait bit of the control panel output word (CPNOT, BIT 5) is set and Routine M exits. If the

flag is not set, the single section flag (SSFW) is reset, the mode change desired flags (MCDF) are set for all sections, the desired mode flags (DMODE) are set to time of day for all sections, the 15-minute section flag (FMSCF) is set, the section number (JJ) is set to zero and Routine W is scheduled. If the time of day bit is not set, the standby bit (CPNIN, WORD3, BIT 11) is checked and if set the mode (MODES) and desired mode flags (DMODE) are set to standby for all sections, the automatic control desired flags (AUTOF) are reset for all controllers, the standby desired flags (STBYD) are set for all controllers. If the standby bit is not set, the record history on bit (CPNIN, WORD3, BIT 12) is checked and if set the record history flag (HRF) is set. If the record history on bit is not set, the record history off bit (CPNIN, WORD3, BIT 14) is checked and if set the record history flag (HRF) is cleared. If none of the bits are set, Routine M takes the error exit. The change table formatting routine (HFMT) is called to log the change and Routine M exits.

If the section bit is set, the first start flag (FSTFL) is checked and if not set Routine M takes the error exit. If the flag is set, the section number is obtained from CPNIN, WORD3, BITS 16-31. If the section number is greater than the number of sections in the system (NMSCT), Routine M takes the error exit. The traffic responsive bit is checked (CPNIN, WORD3, BIT 8) and if it is set the 15-minute section flag (FMSCF) is checked. If the flag is set, the wait bit of the control panel output word (CPNOT, BIT 5) is set and Routine M exits. If the flag is not set, the mode change desired flags (MCDF) are set for the section and the desired mode flags (DMODE) are set to traffic responsive for the section. If the traffic responsive bit is not set, the time of day bit (CPNIN, WORD3, BIT 9) is checked and if it is set the 15-minute section flag (FMSCF) is checked. If the flag is set, the wait bit of the control panel output word (CPNOT, BIT 5) is set and Routine M exits. If the flag is not set, the single section flag (SSFW) is set, the mode change desired flags (MCDF) are set for the section, the desired mode flags

(DMODE) are set to time of day for the section, the 15-minute section flag (FMSCF) is set, the section number (JJ) is set equal to the input section number minus 1, and Routine W is scheduled. If the time of day bit is not set, the manual pattern bit (CPNIN, WORD4, BIT 0) is checked and if it is set the pattern number is obtained from CPNIN, WORD4, BITS 4 - 15. A check is made to see if this is a valid pattern number of this time of day. If it isn't Routine M takes the error exit. If it is a valid pattern number the 15-minute section flag (FMSCF) is checked. If the flag is set, the wait bit of the control panel output word (CPNOT, BIT 5) is set and Routine M exits. If the flag is not set, the mode change desired flags (MCDF) is set for this section, the desired mode flags (DMODE) are set to manual pattern for this section, the desired pattern number (DPTNM) is set equal to the inputted pattern number minus one, the 15-minute section flag (FMSCF) is set, the section number (JJ) is set equal to the inputted section number minus 1, and Routine W is scheduled. If the manual pattern bit is not set, the standby bit (CPNIN, WORD3, BIT 11) is checked and if it is set the mode (MODES) and desired mode flags (DMODE) are set to standby for this section, the automatic control desired flags (AUTOF) are reset for all controllers in section and the standby desired flags (STBYD) are set for all controllers in section. If none of the bits are set, Routine M takes the error exit. The change table formatting routine (HFMT) is called to log the change and Routine M exits.

If the controller bit is set, the controller number is obtained from CPNIN, WORD3, BITS 16 - 31. If the inserted number is greater than the number of controllers in the system (NMCTL), Routine M takes the error exit. The failure repair bit (CPNIN, WORD3, BIT 15) is checked and if it is set the acknowledge/repair failure table routine (KFMT) is called to log the repair. If the failure is not in the table (FLTAB), Routine M takes the error exit. After the repair is logged, the controller malfunction flag (CMALF) is cleared for this controller. If the failure repair bit is not set, the first start flag (FSTFL) is checked. If the flag is not set, Routine M takes the error exit. If the flag is set, the on-line bit (CPNIN, WORD3, BIT 10) is

checked and if it is set the section containing this controller is checked to see if the section is in standby. If it is, Routine M takes the error exit. Next a check is performed to see if this controller's malfunction flag (CMALF) is set. Again Routine M takes the error exit if the flag is set. Finally a check is made to see if the controller is in standby (HOLD) and if it is not Routine M takes the error exit. If all the tests are passed, the automatic desired flag (AUTOF) for this controller is set. If the on-line bit is not set, the standby bit (CPNIN, WORD3, BIT 11) is checked and if it is set the standby desired flag (STBYD) is set for this controller and the automatic desired flag (AUTOF) is reset for this controller. If the on-line bit is not set, the failure acknowledge bit (CPNIN, WORD3, BIT 13) is checked and if this bit is set the acknowledge/repair failure table routine (KFMT) is called to log the acknowledge. If the failure is not in the failure table (FLTAB), Routine M takes the error exit. If the failure acknowledge bit is not set the A-Phase Green bit (CPNIN, WORD4, BIT 1) is checked and if set the controller in standby flag (HOLD) is checked for this controller. If this controller is in standby, Routine M takes the error exit. If this controller is not in standby, a check is performed to see if it is currently operating as a CIC controller (CICEF = 1). If it is, Routine M takes the error exit. The request must wait if the controller is to be placed into transition (TRNSF = 1), is in transition (MI $\neq$ 0) or the 15-minute section flag (FMSCF) is set. If the request must wait, the wait bit of the control panel output word (CPNOT BIT 5) is set and Routine M exits. If the request is to be handled now, the A-Phase Green is obtained from CPNIN WORD 4, BITS 4 - 15. If the inserted A-Phase Green is less than the min (GMABC) allowed for this controller, Routine M takes the error exit. Using the inserted A-Phase Green a new B-Phase Green is computed, if this is less than the min (GMABC) allowed for this controller, Routine M takes the error exit. If the inserted value is good, the operator adjusted A-Phase Green (GAWTP) and the operator adjusted B-Phase Green (GBWTP) are stored for this controller. The operator split change flag (SPLCH) is set for this controller. The new split value SPLIT (controller) = $\left[\frac{\text{VPHASA}}{\text{VPHASB}}\right]$ x 1000 is then stored and

the hold split flag (HLDSPL) is set for this controller. If the A-Phase Green bit is not set, the offset bit (CPNIN, WORD4, BIT 2) is checked and if it is set the controller in standby flag (HOLD) is checked for this controller. If this controller is in standby, Routine M takes the error exit. If the controller is not in standby, a check is performed (just as in the A-Phase Green case above) to see if the controller is in transition, about to be placed in transition or the 15-minute section flag (FMSCF) is set. If any of these conditions are met, the request must wait. The offset value is obtained from CPNIN, WORD4, BITS 4 - 15. If the inserted offset is greater or equal to the cycle length (KCL), Routine M takes the error exit If it is a valid offset, it is stored as the working offset (WRKOF) for this controller and the offset change flag (FSTCF) is set for this controller. The relationships between the selected offset for this controller and the offsets for its neighbor are recorded. The hold offset flag (HLDOFF) is set for this controller. If none of the bits are set, Routine M takes the error exit. The change table formatting routine (HFMT) is called to log the change and Routine M exits.

If the detector bit was set, the detector number is obtained from CPNIN, WORD3, BITS 16 - 31. If the detector number that is inserted is greater than the number of detectors in the system (NMVED), Routine M takes the error exit. If the inserted detector number is valid, the on-line bit (CPNIN, WORD3, BIT 10) is checked and if it is set the detector failure flag (DMALF) and the communications failure flag (MMALF) is checked for this detector. If either are set, Routine M takes the error exit. If the detector is operating, the detector standby flag (DIS) is cleared for this detector. If the on-line bit is not set, the standby bit (CPNIN, WORD3, BIT 11) is checked and if set the detector standby flag (DIS) is set for this detector. If the detector in standby bit is not set, the failure repair bit (CPNIN, WORD3, BIT 15) is checked and if set the acknowledge/repair failure table routine (KFMT) is called to log the repair. If the failure is not in the table (FLTAB), Routine M takes the error exit. After the repair is logged, the detector failure flag (DMALF) is cleared for this detector. If

the failure repair bit is not set, the failure acknowledge bit (CPNIN, WORD3, BIT 13) is checked and if it is set a check is made of the first start flag (FSTFL). If this flag is not set, Routine M takes the error exit. If the flag is set, the acknowledge/repair failure table routine is called to log the acknowledge. If the failure is not in the table (FLTAB), Routine M change table formatting routine (HFMT) is called to log the change and Routine M exits.

If the communications bit was set, the logic is exactly the same as for detector except that the only valid requests are for failure repair and failure acknowledged, and on a failure repair the corresponding communications failure flag (CMMAL) is cleared.

CIC -- The system bit (CPNIN, WORD3, BIT 3), the section bit (CPNIN, WORD3, BIT 10) is checked and if it is set the CIC selected flags (CICSF) are set for all CIC controllers in the system (CICSY). If the activate bit is not set, the release bit (CPNIN, WORD3, BIT 11) is checked and if it is set all the CIC selected flags (CICSF) are cleared for all CIC controllers in the system (CICSY). If none of the bits are set, Routine M takes the error exit. The change table formatting routine (HFMT) is called to log the change.

If the section bit is set, the section number is obtained from CPNIN, WORD3, BITS 16 - 31. If the inserted number is greater than the max number of sections (NMSCT), Routine M takes the error exit. If the inserted section number is valid, the activate bit and release bit are checked and processed just as in system entry, except now the CIC selected flags (CICSF) are processed only for the section.

If the controller bit is set, the controller number is obtained from CPNIN, WORD3, BITS 16 - 31. If the inserted number is greater than the maximum number of controllers (NMCTL), Routine M takes the error exit. If

the inserted number is valid, the activate bit (CPNIN, WORD3, BIT 10) is checked and if it is set the possible CIC flag (CICSY) associated with controller is checked. If this is not a CIC controller, Routine M takes the error exit. If it is a CIC controller, the CIC selected flag (CICSF) associated with this controller is set. If the activate bit is not set, the release bit (CPNIN, WORD3, BIT 11) is checked and if set the CIC selected flag (CICSF) associated with this controller is cleared. If none of the bits are set, Routine M takes the error exit. The change table formatting routine (HFMT) is called to log the changes.

Map Enter -- If the map enter bit (CPNIN, WORD1, BIT 1) is set, the map ready bit of the control panel output word (CPNOT, BIT 1) is set. Routine M then begins to format the inputs from the control panel and stores them away for Routine J (Map Control Routine). The controller display code (CNDIS) is set for Routine J. If the A-Phase Green bit (CPNIN, WORD1, BIT 12) is set, then CNDIS = 0 (CONTROLLER DISPLAY ON). If the controller display off bit (CPNIN, WORD1, BIT 15) is set, then CNDIS = 1 (CONTROLLER DISPLAY OFF). Next the surveillance off bit (CPNIN, WORD1, BIT 11) is checked and if it is set the surveillance display code (SRDIS) is set to zero (SURVEILLANCE OFF) for Routine J.

After checking the three bits mentioned above and making changes to CNDIS and SRDIS, if necessary, the traffic control bit (CPNIN, WORD1, BIT 5), the BPS bit (CPNIN, WORD1, BIT 7), the CIC bit (CPNIN, WORD1, BIT 6), and the controller status bit (CPNIN, WORD1, BIT 13) are checked. If none of the bits are set, Routine J is scheduled and Routine M exits.

If the traffic control bit is set, the flow data bit (CPNIN, WORD1, BIT 8) is checked and if set the flow parameter is found by checking bits 16 - 21 of CPNIN, WORD1. The selected threshold is obtained from CPNIN, WORD1, BITS 22 - 31. A corresponding threshold value is obtained from a fixed internal table (THRVL) and stored into the flow data threshold array (THRSH)

for Routine J. The flow parameter code is stored into the flow data parameter code array (PRCOD) for Routine J. These codes are:

0 - Occupancy
1 - Volume
2 - Queue

The surveillance display code (SRDIS) is set to 3 (FLOW DATA). Next the controller status bit (CPNIN, WORD1, BIT 13) is checked and if set the controller display code (CNDIS) is set to 2 (CONTROLLER STATUS). If the controller status bit is not set, the failed bit (CPNIN, WORD1, BIT 14) is checked and if set the controller display code (CNDIS) is set to 3 (CONTROLLERS FAILED). Routine J is scheduled and the Routine M exits.

If the flow data bit is not set, it is not necessary to look for flow data parameters and threshold values. Instead the equipment failed bit (CPNIN, WORD1, BIT 10) is checked and if set the surveillance display code (SRDIS) is set to 1 (TCS EQUIPMENT FAILED). Next the program checks the controller status bit and proceeds exactly as above when flow data was selected.

Display Enter -- If the display enter bit (CPNIN, WORD1, BIT 2) is set, the display ready bit of the control panel output word (CPNOT, BIT 2) is set. A check is made to see which CRT has been selected. If neither, Routine M takes the error exit. At the error exit the display error bit of the control panel output word (CPNOT, BIT 4) is set. If CRT number 1 is chosen (CPNIN, WORD2, BIT 8), then the CRT number 1 flag (CRTF1) is set. If CRT number 2 is chosen (CPNIN, WORD2, BIT 9), then the CRT number 2 flag (CRTF2) is set. In either case the program then proceeds to get the CRT display code for Routine K. If the traffic failure bit (CPNIN, WORD2, BIT 11), the traffic system bit (CPNIN, WORD2, BIT 12), the controller bit (CPNIN, WORD2, BIT 13), traffic system detector bit (CPNIN, WORD2, BIT 14), or the traffic system intersection bit (CPNIN, WORD2, BIT 15) are set the corresponding CRT display codes are placed into CRTD1 (for CRT 1

selected) or CRTD2 (for CRT 2 selected) for Routine K. These codes are as follows:

1 - Traffic Failure
2 - Traffic System
3 - Controller
4 - Traffic System Detector
5 - Traffic System Intersection

If traffic system intersection is selected, the intersection number is obtained from bits 20 - 31 of CPNIN, WORD2. If the inserted number is greater than the number of controllers in the system (NMCTL), Routine M takes the error exit. After the display code is stored a check is made to see if it has been more than 6 seconds since Routine K was scheduled. If it has, Routine K is scheduled and Routine M exits. If it has not been that long Routine M exits without scheduling Routine K.

Several small updates have been made to Routine M to support the second generation software system. First since the BPS capability has been deleted from the second generation system, Routine M has been modified to give an operator input error if any BPS system control functions or any BPS CRT report is attempted to be selected by the operator.

Second, to provide for proper second generation traffic responsive capability, Routine M has been modified to schedule Routine W immediately upon entering a traffic responsive system or section mode request. This scheduling is so that Routine W can set the Level 5 Start Flags (LEV5SF) which in turn will be interrogated by the Level 5 executive (MACRO) at the next 5MINCT mark and will activate the Traffic Signal Optimization Routine (LSTSQS).

Routine M has also been modified to give a "wait" response on the control panel if a traffic system control mode change is requested which the Level 5

software is active. The Level 5 active state is determined by testing the LEVL5A flag which is set upon entry to Routine MACRO and reset upon exit of that routine. The "wait" indication is also given if a controller split change is requested or if a controller offset change is requested while Level 5 is active. This "wait" is imposed so that controller offsets and splits are not lost due to a multiple transition which could occur if the requests are accepted. This response is similar to the one given in the first generation software if any of the above requests are entered while the FMSCF is set indicating that Routine W is active.

The reader should refer to Section 2.14 of Reference 2 to trace the following description of the particular portions of the code of Routine M which have been modified.

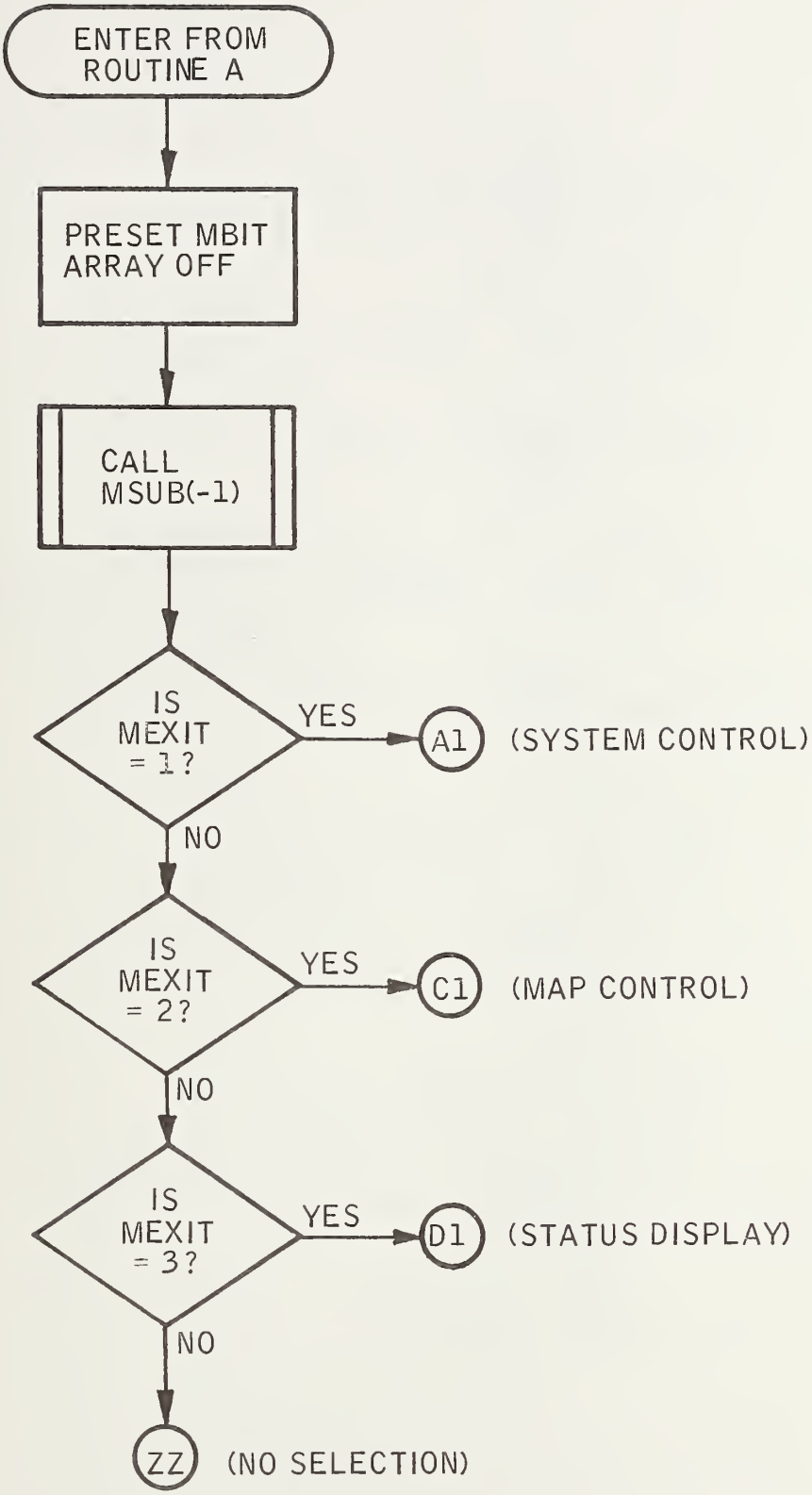
In the traffic responsive mode, after the 15-minute section flag (FMSECF) is checked, a check on the LEVL5A flag is performed. If the LEVL5A flag is not set, the wait exit (Y) is taken. If the LEVL5A flag is set then SSFW is reset, FMSECF is set, JJ is reset, and Routine W is scheduled. Then the code proceeds as shown. Also, in the Time-of-Day, after the FMSECF flag is checked, a check on the LEVL5A flag is performed. If it is not set, the wait exit (Y) is taken. If it is set, then the code proceeds as shown.

In the Traffic Response (Time-of-Day and Manual Pattern) mode after the FMSECF flag is checked, a check on the LEVL5A flag is performed. If it is not set, the wait exit (Y) is taken. If it is set then the code proceeds.

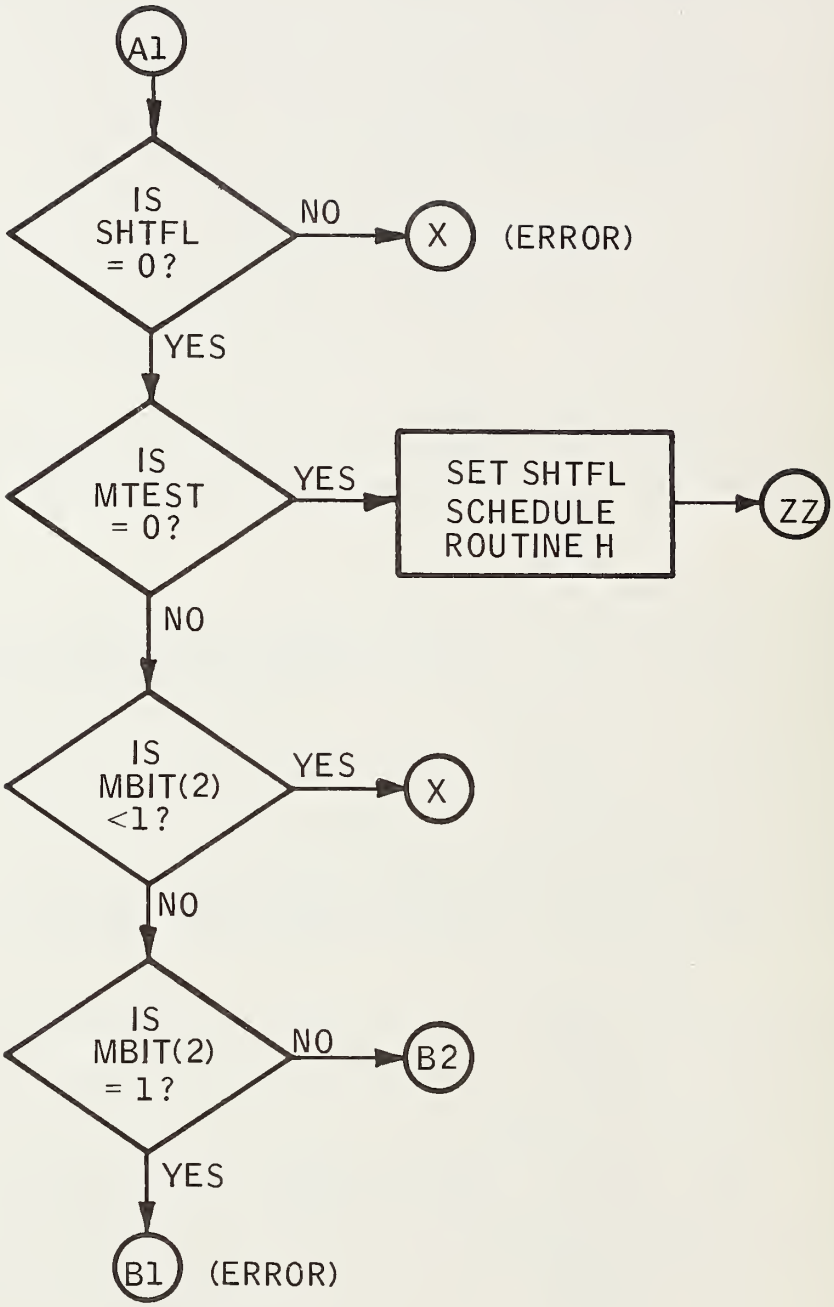
In A-Phase Green and offset, after the FMSECF flag is checked, a check on the LEVL5A flag is performed. If it is not set, the wait exit (Y) is taken. If it is set then the code proceeds.

2.6.51.5 Listing

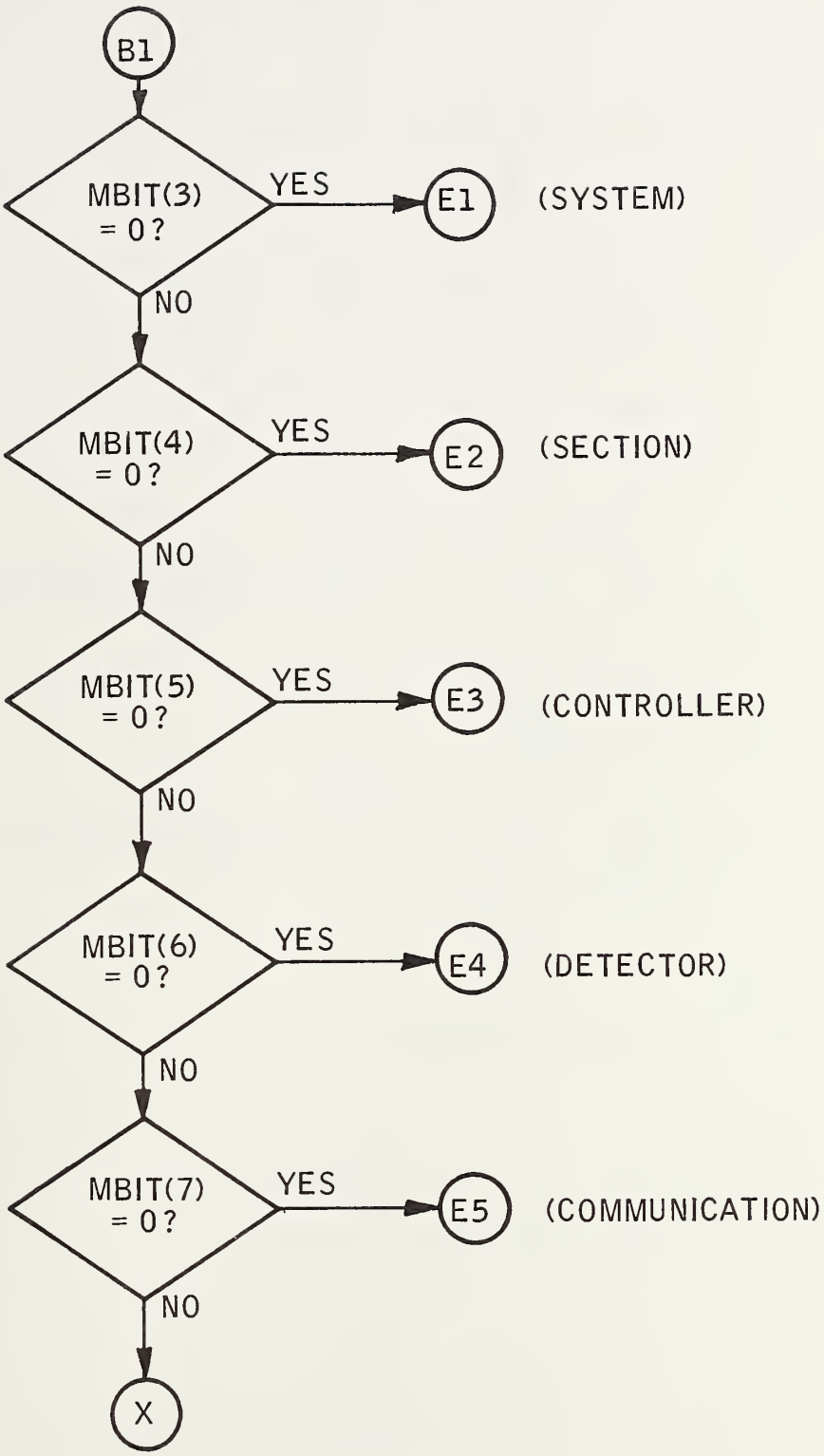
See Volume III, 2GCF Routine Listings.


ENTER FROM ROUTINE A
PRESET MBIT ARRAY OFF
CALL MSUB(-1)
IS MEXIT = 1?
YES
A1
(SYSTEM CONTROL)
NO
IS MEXIT = 2?
YES
C1
(MAP CONTROL)
NO
IS MEXIT = 3?
YES
D1
(STATUS DISPLAY)
NO
ZZ
(NO SELECTION)

Routine M



Routine M (Continued)



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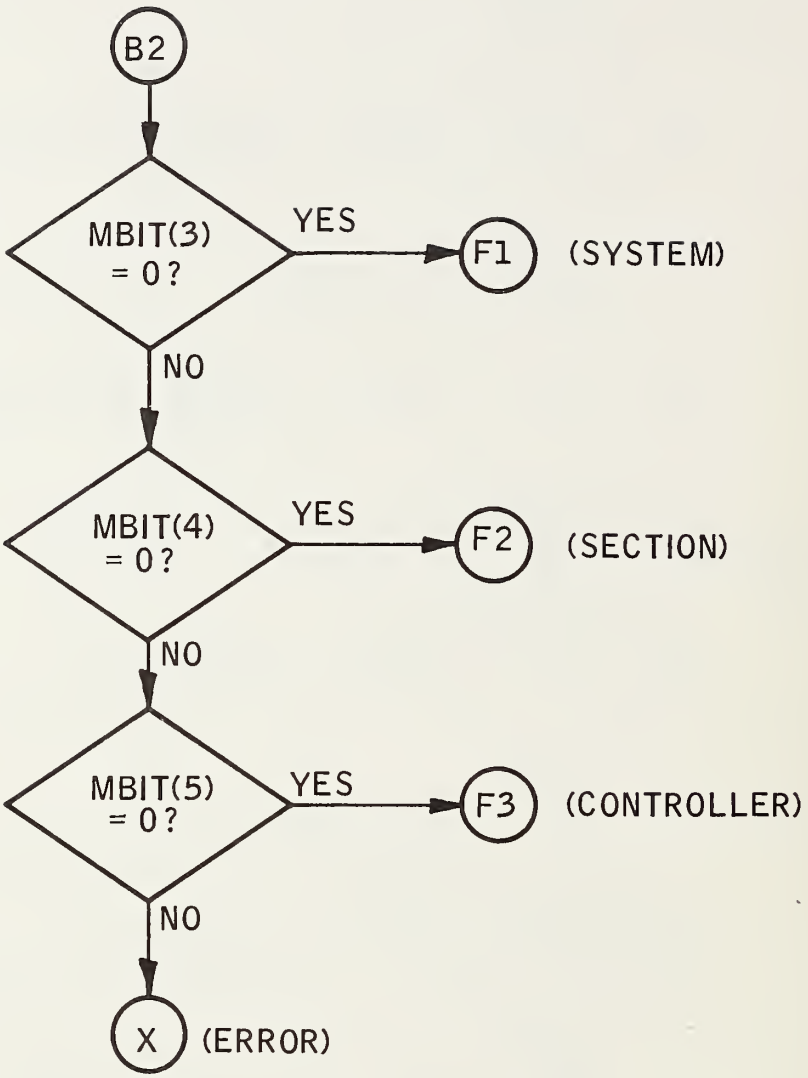

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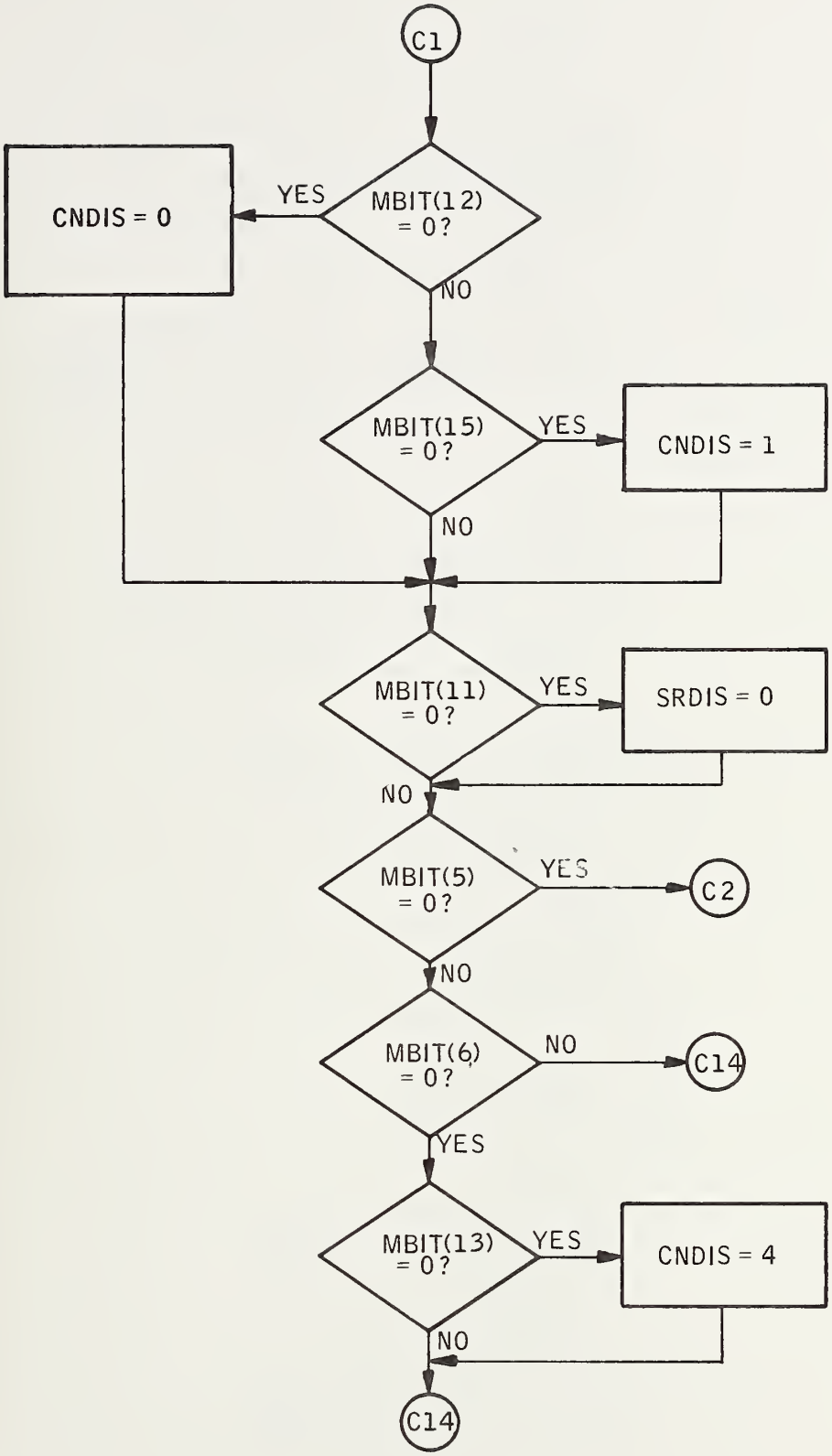

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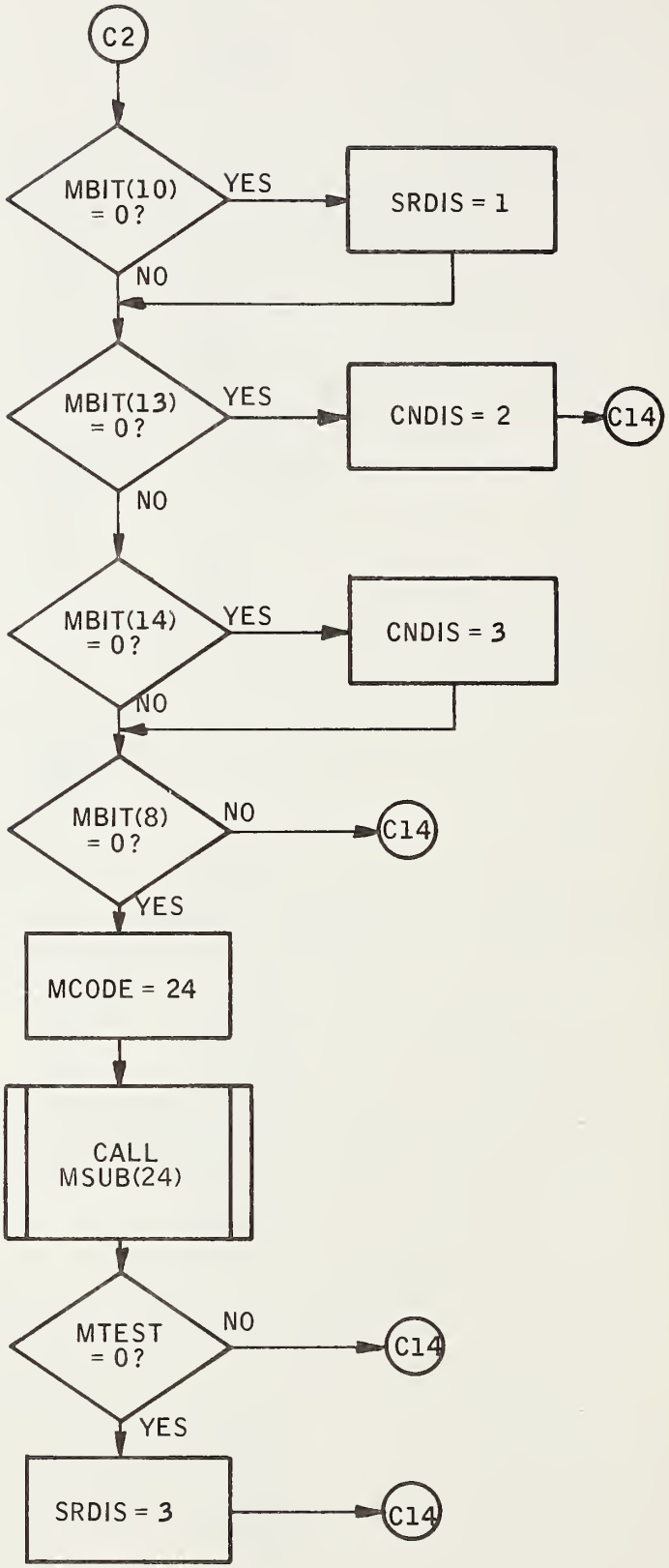

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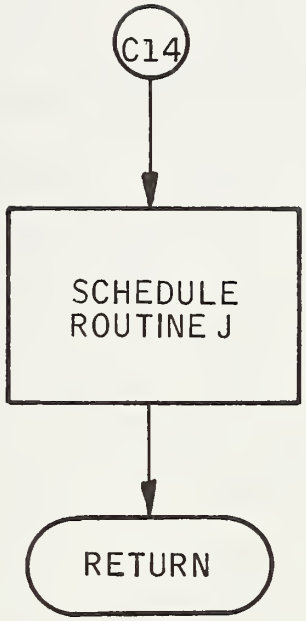

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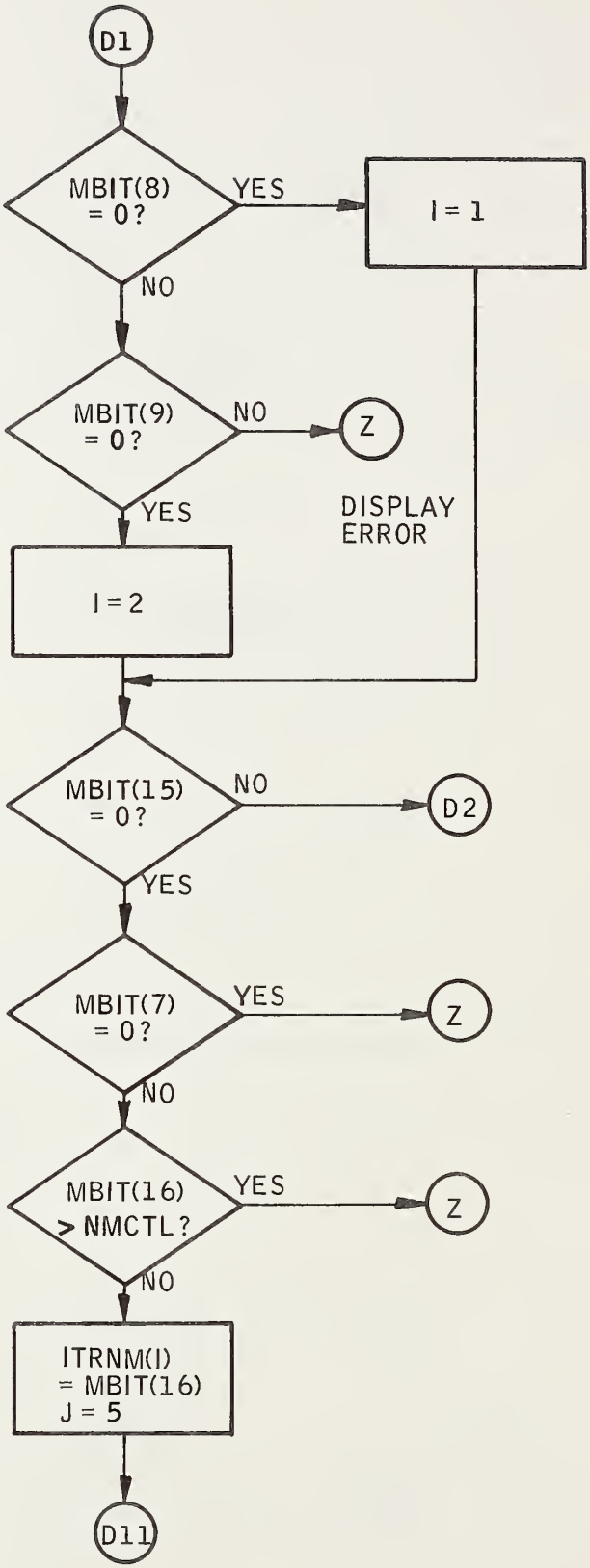

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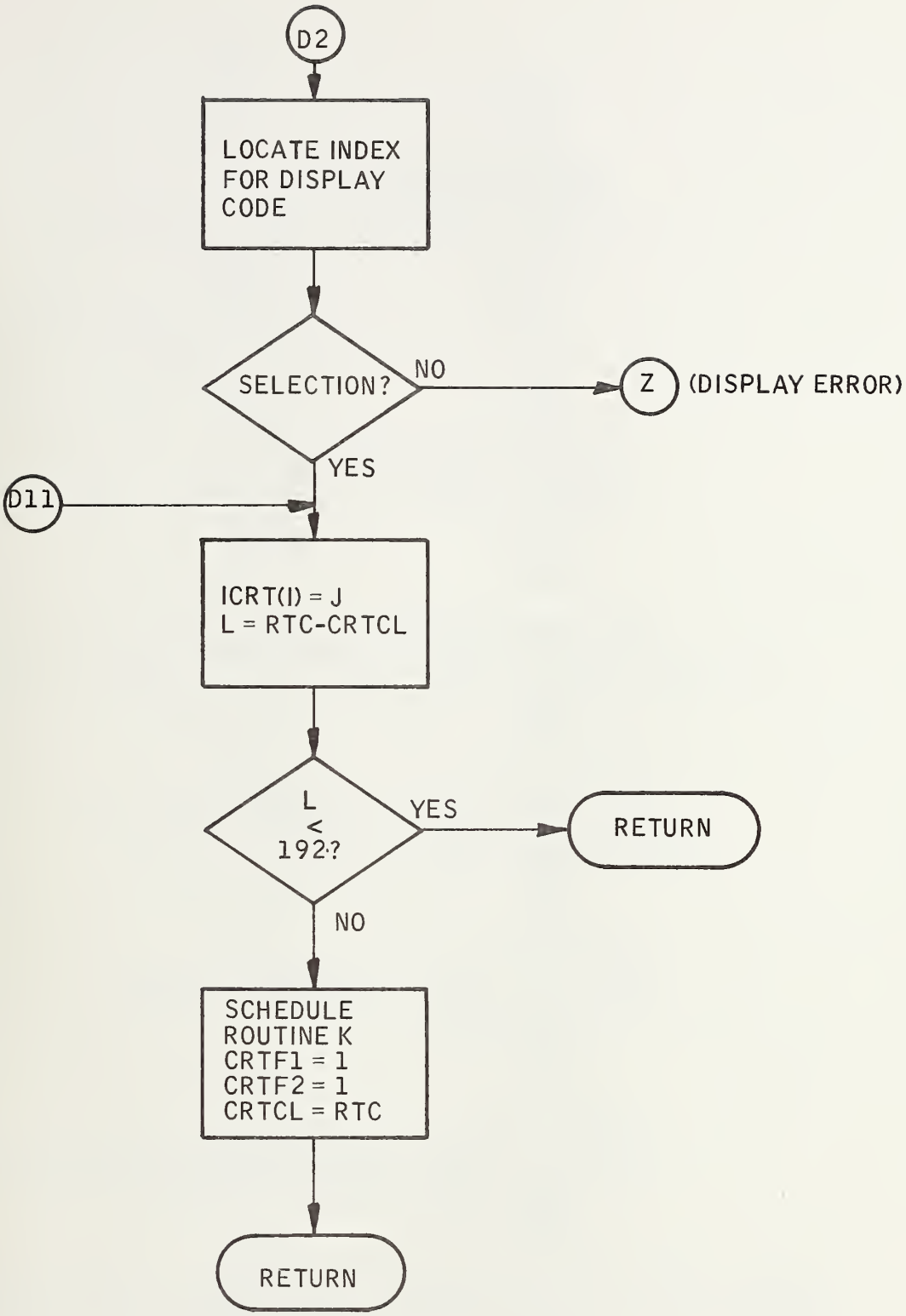

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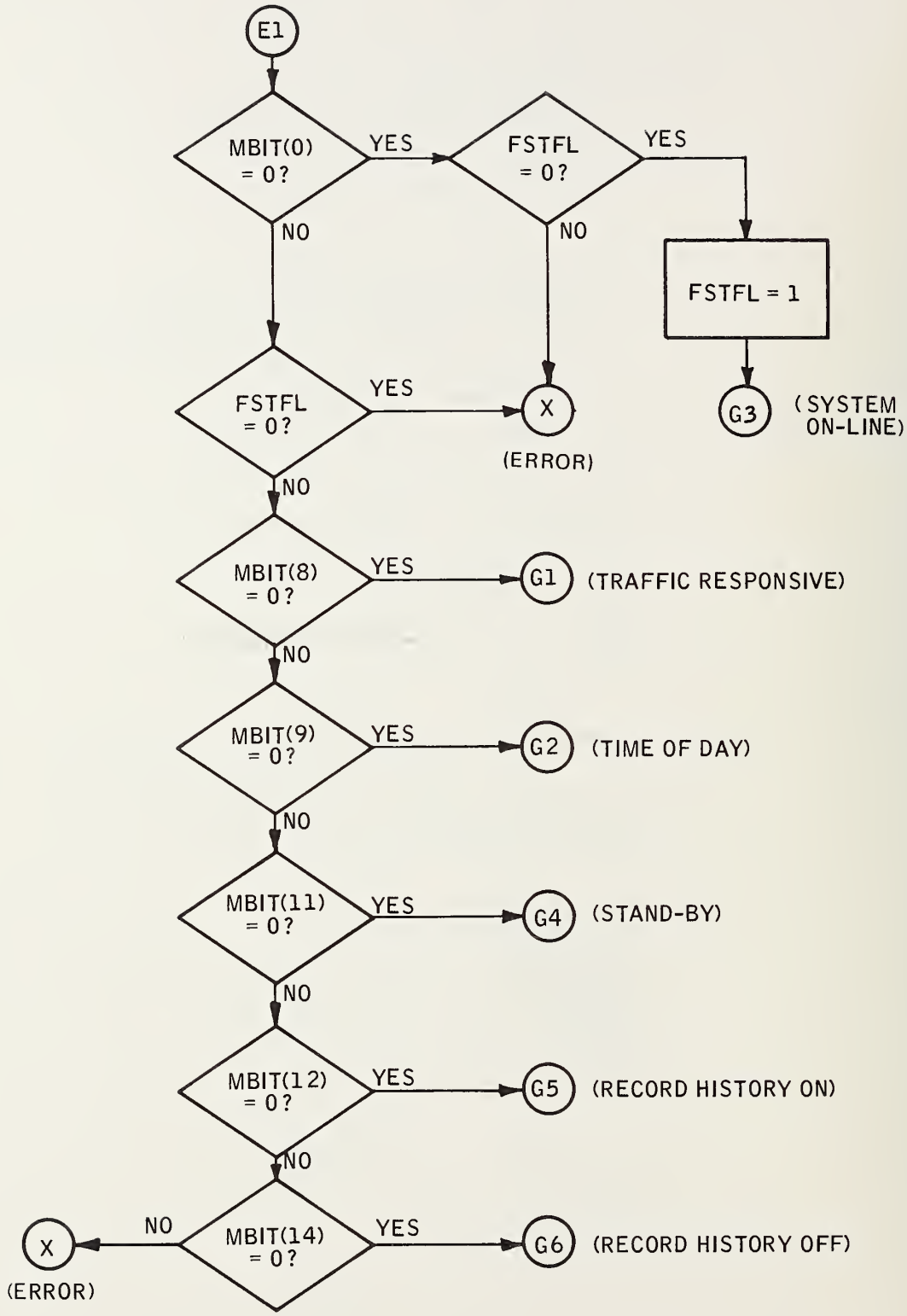

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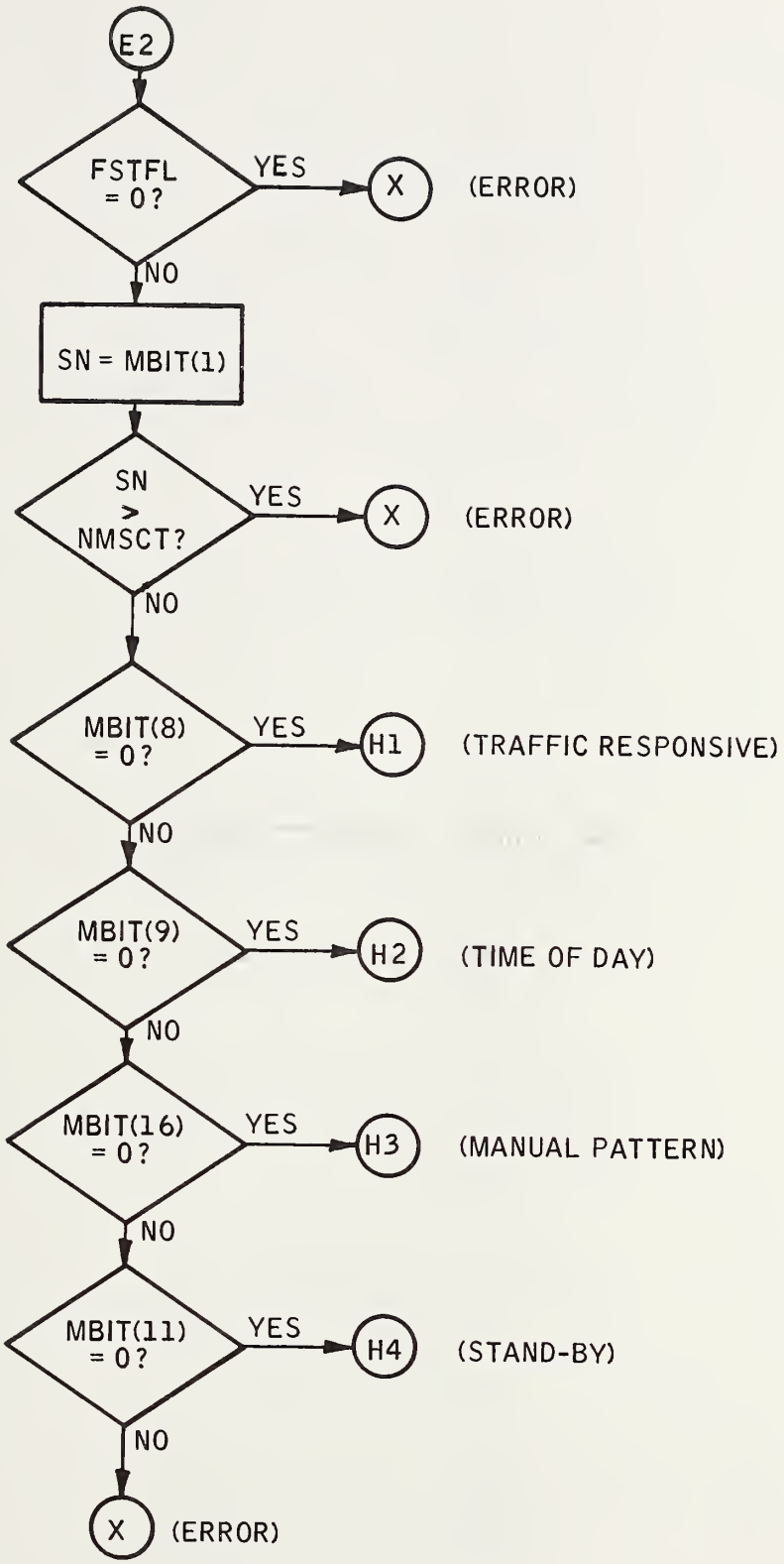

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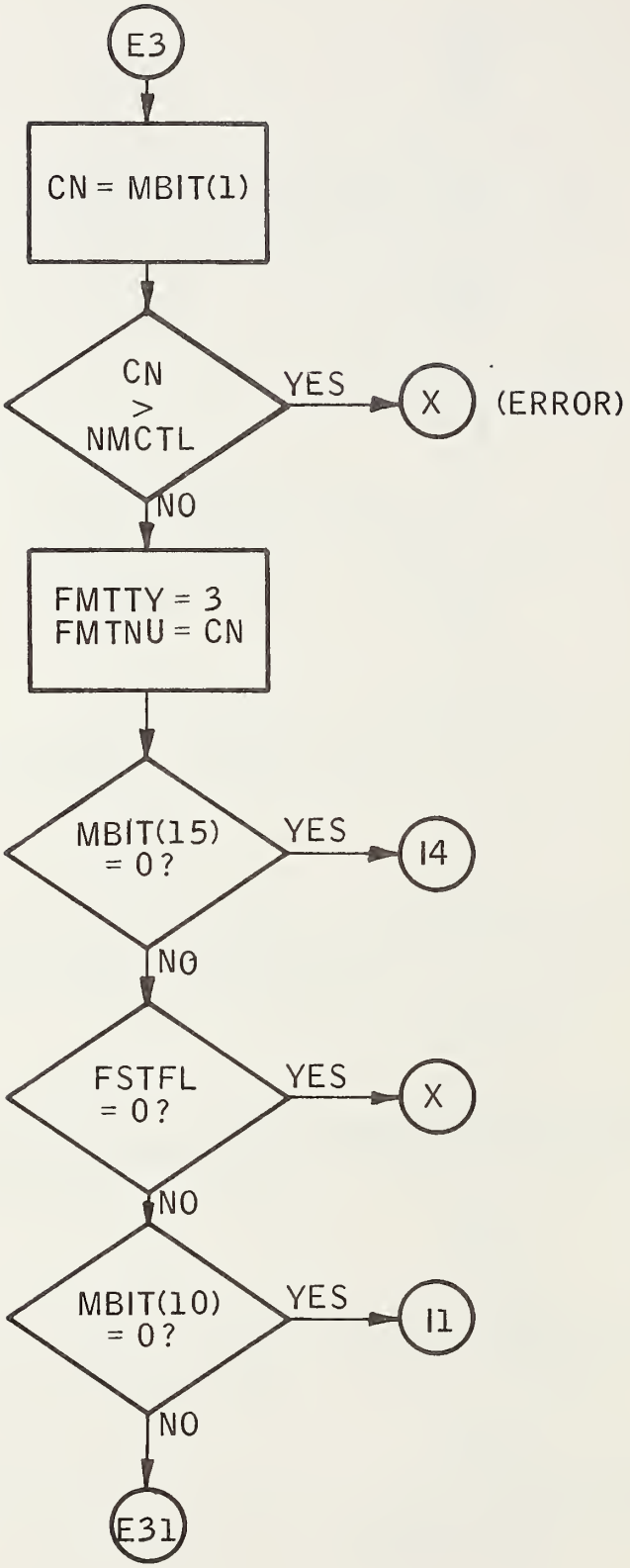

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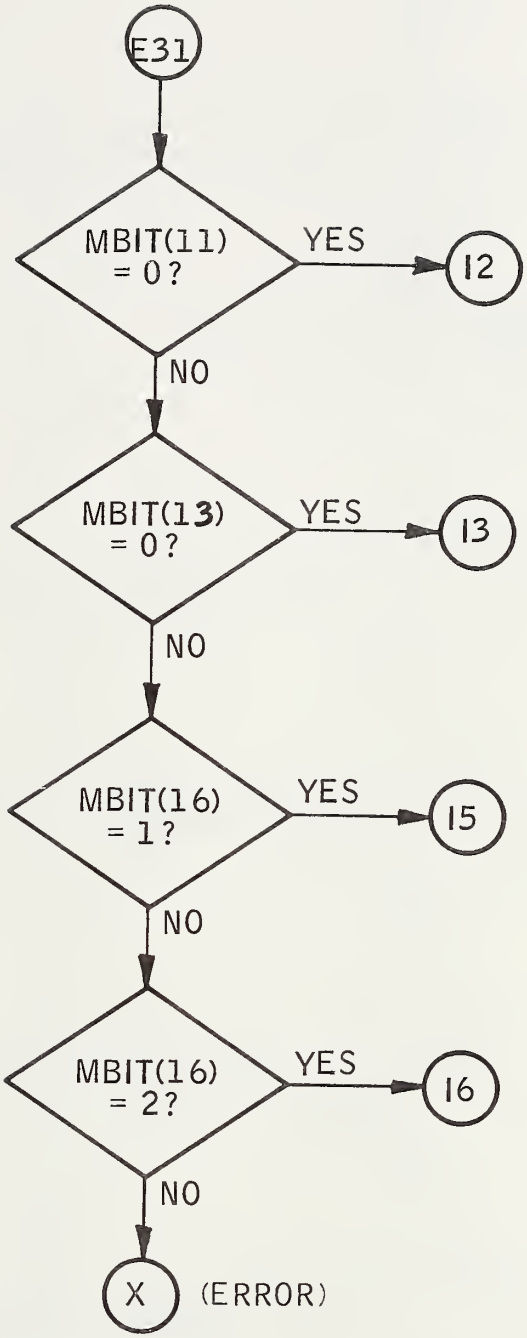

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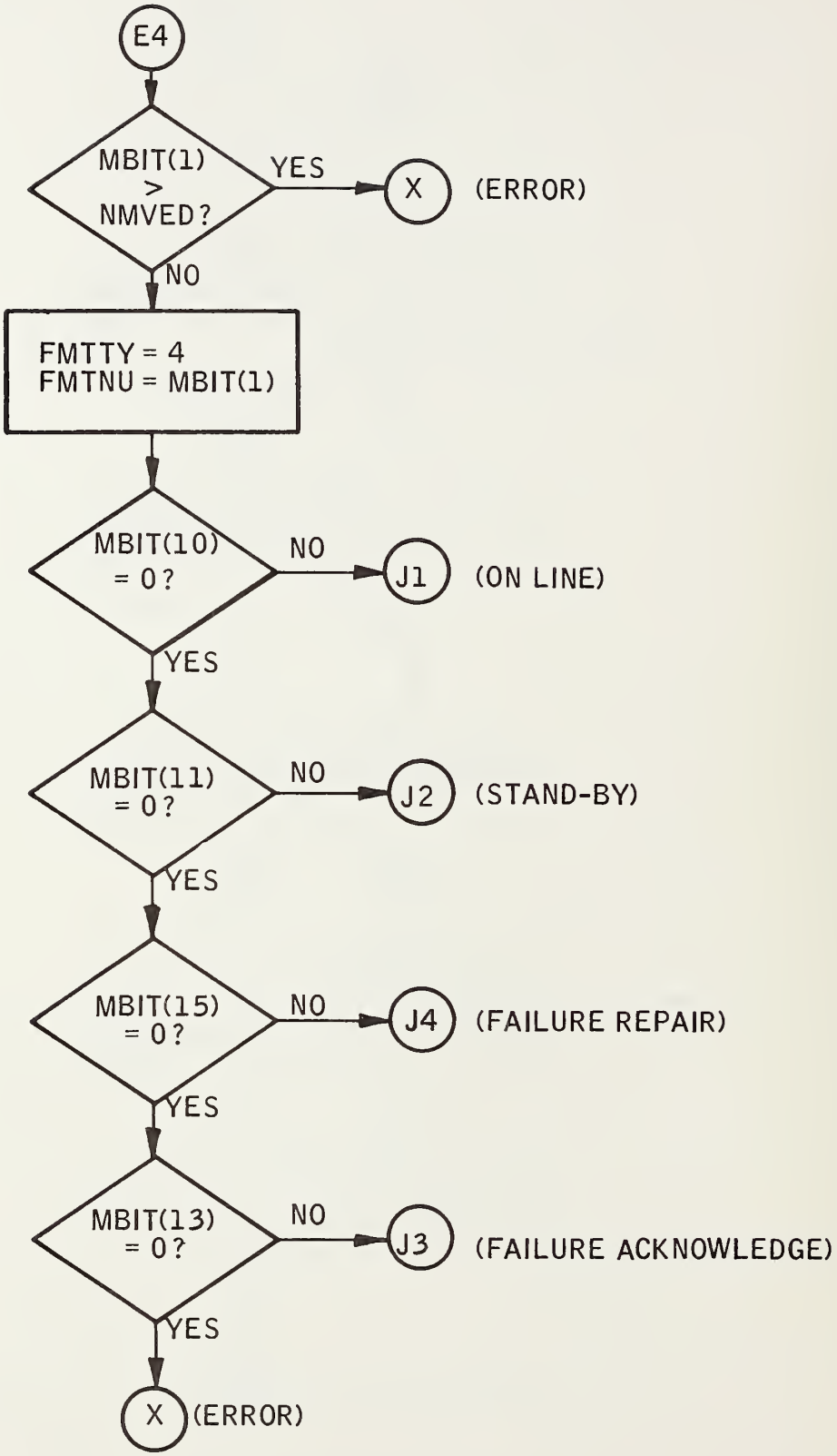

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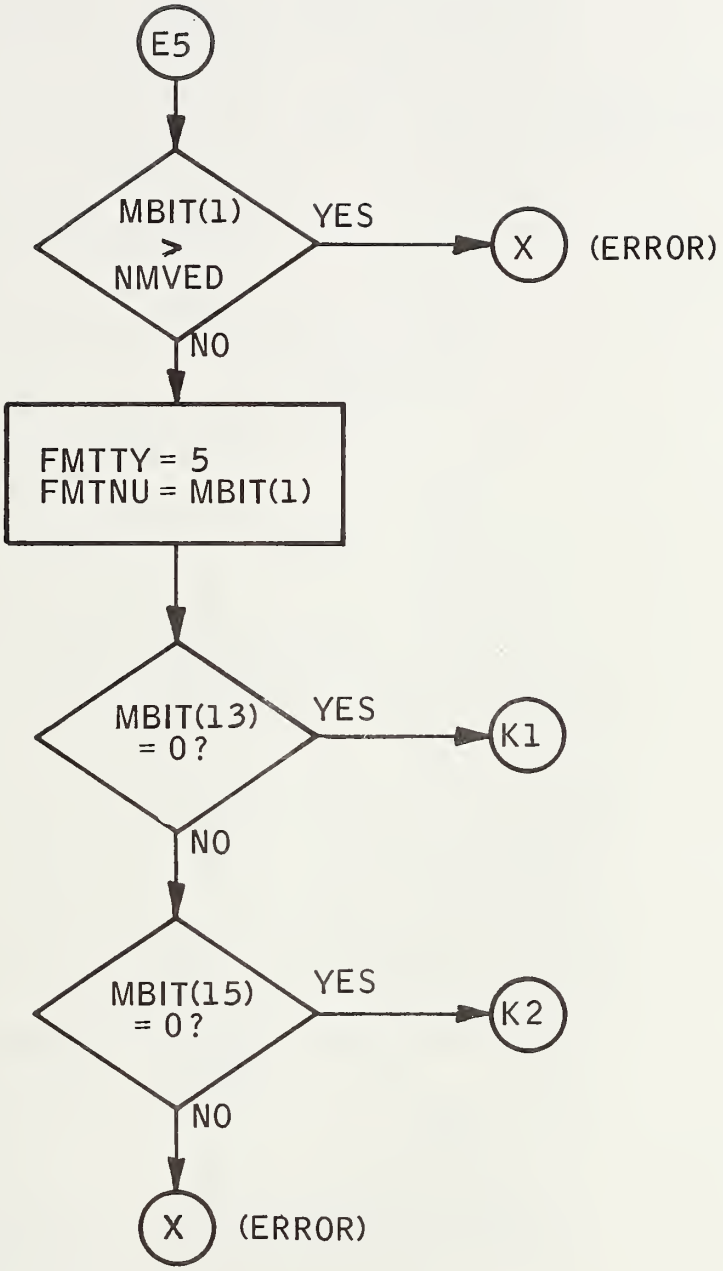
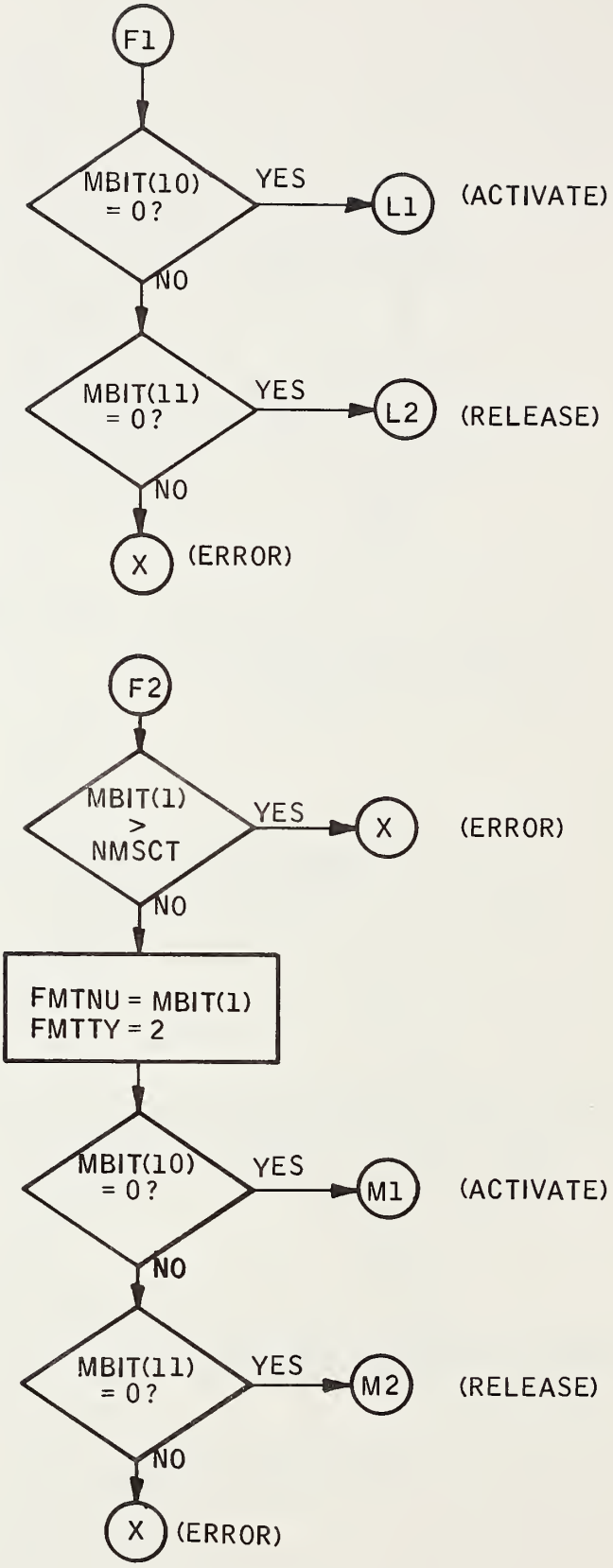


Routine M (Continued)



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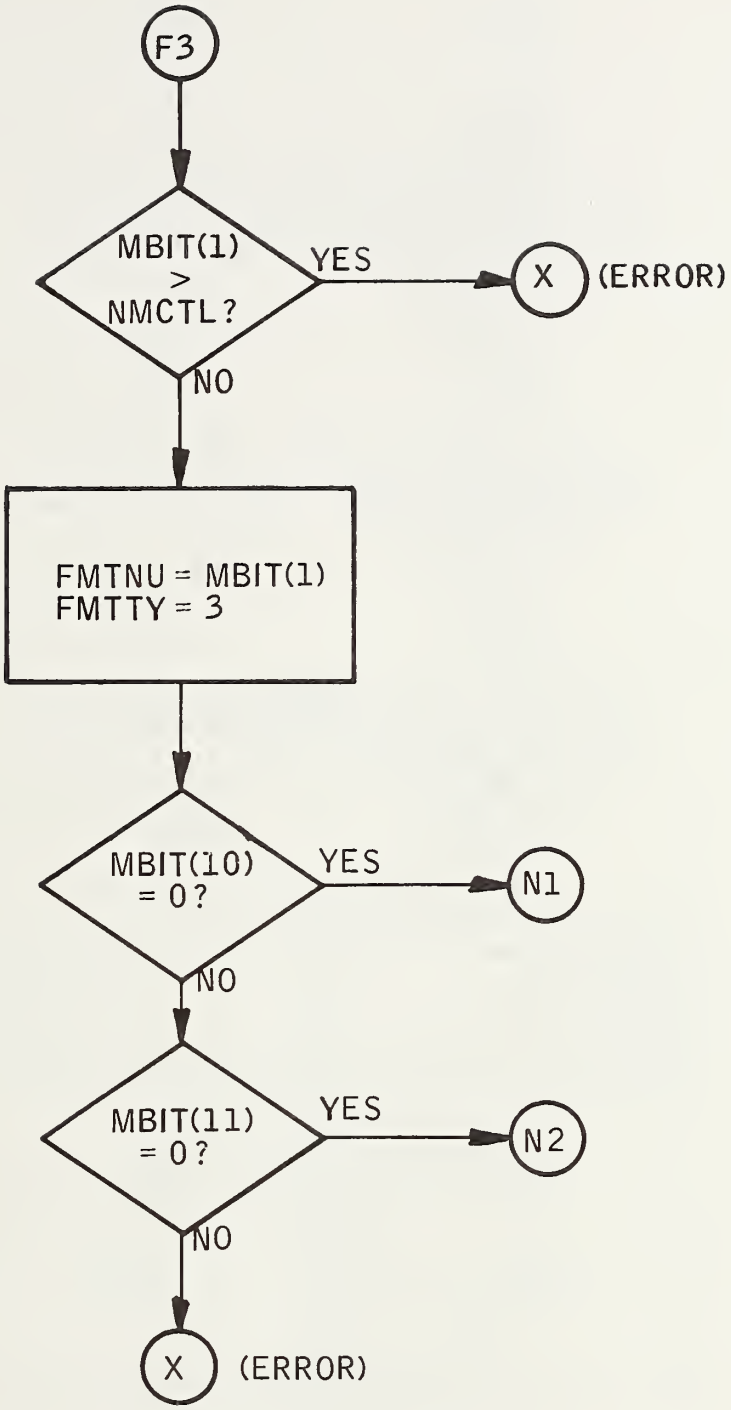

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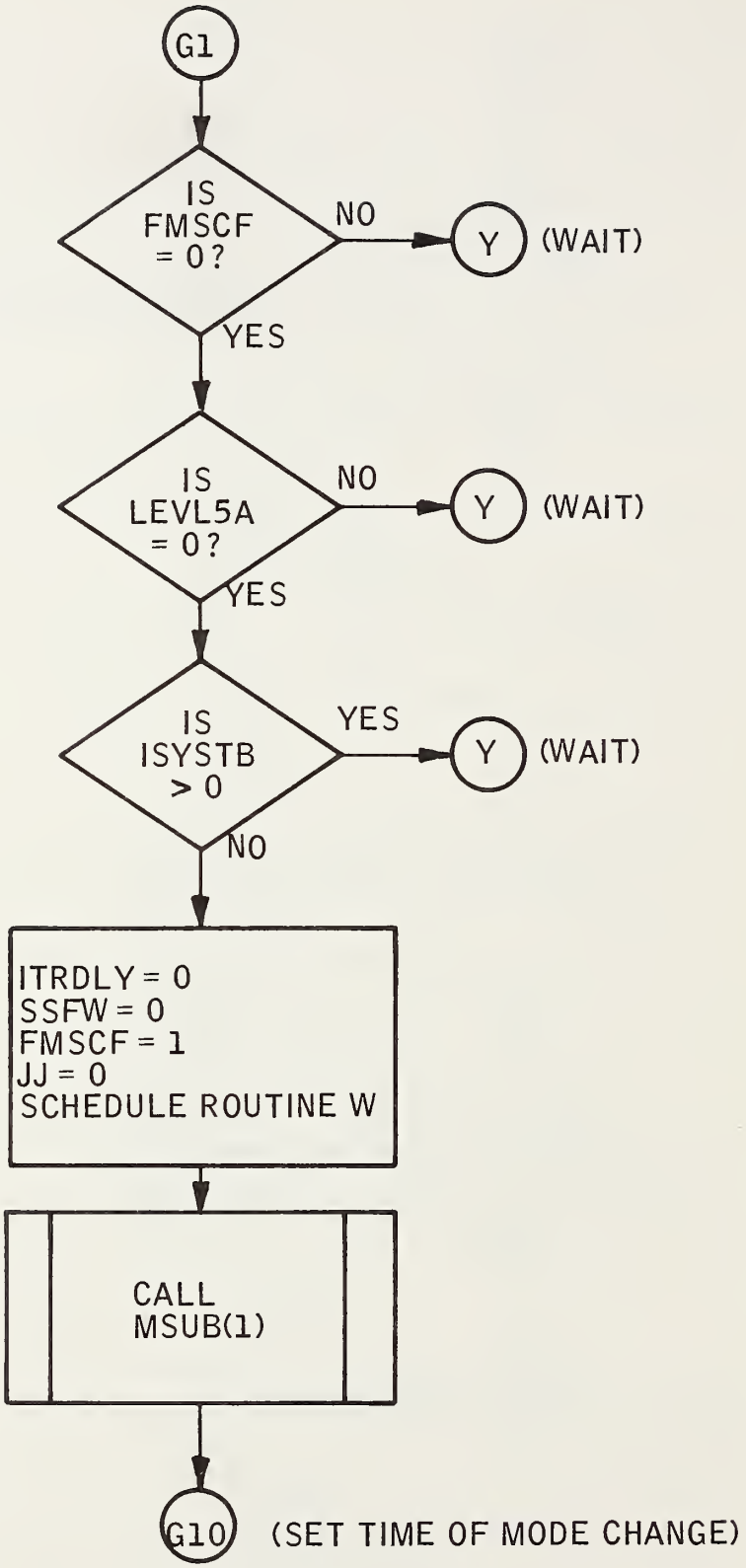

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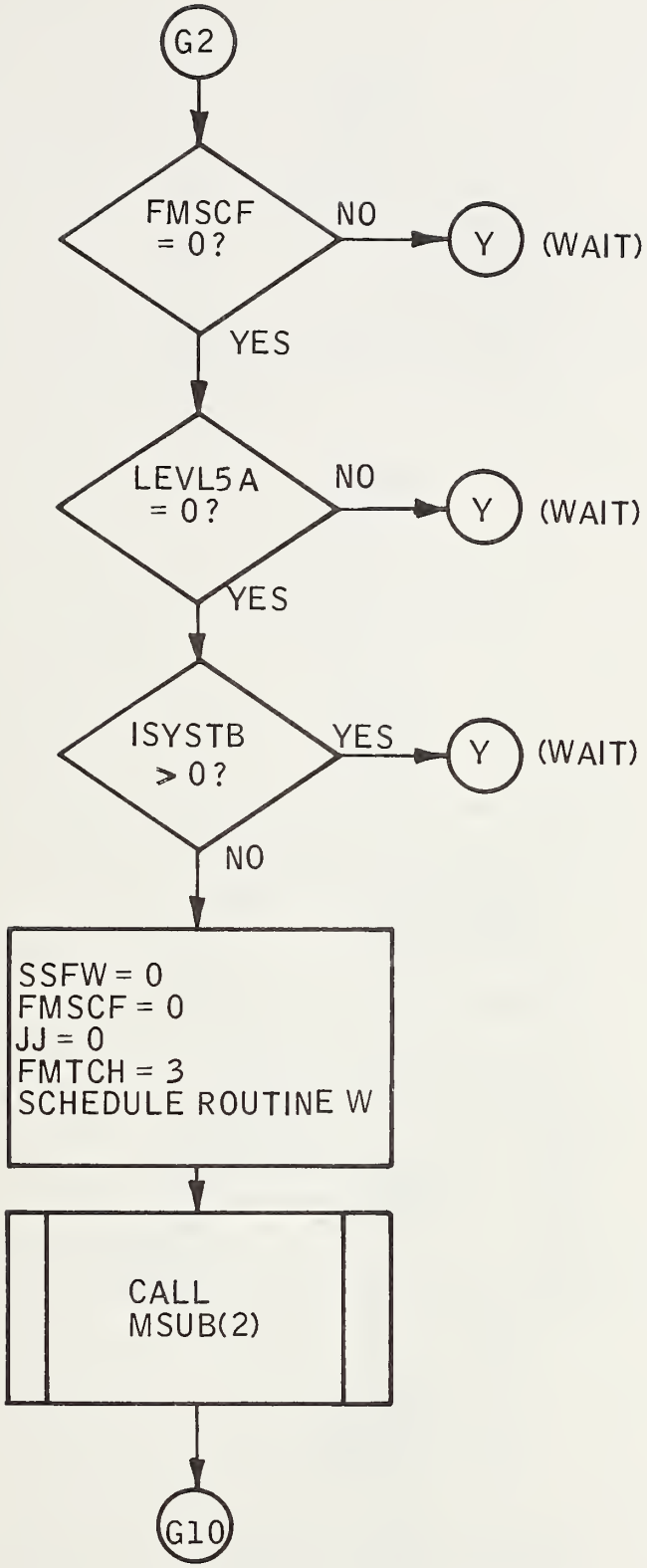

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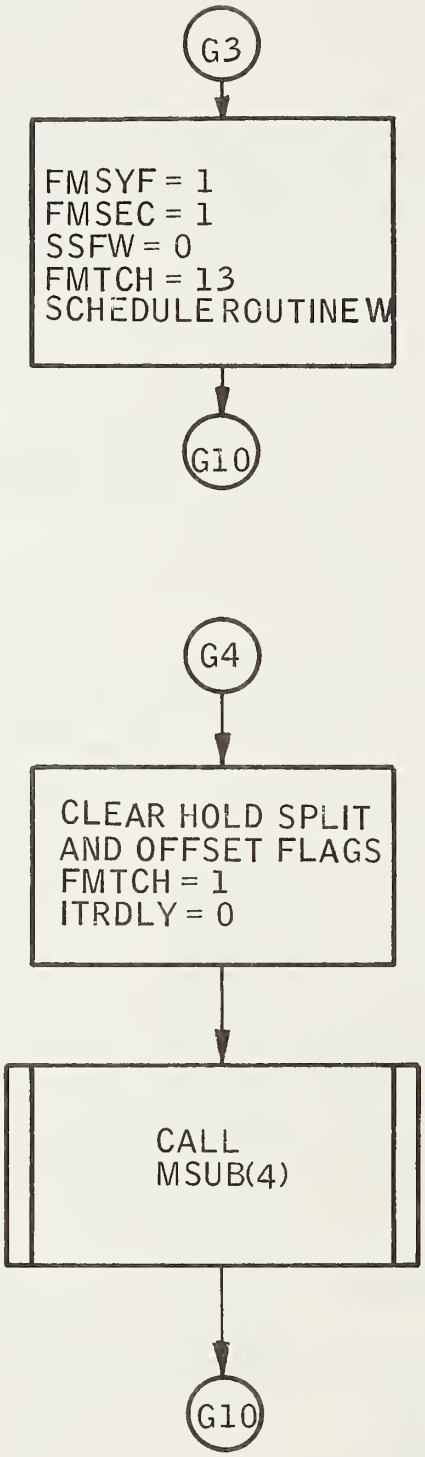

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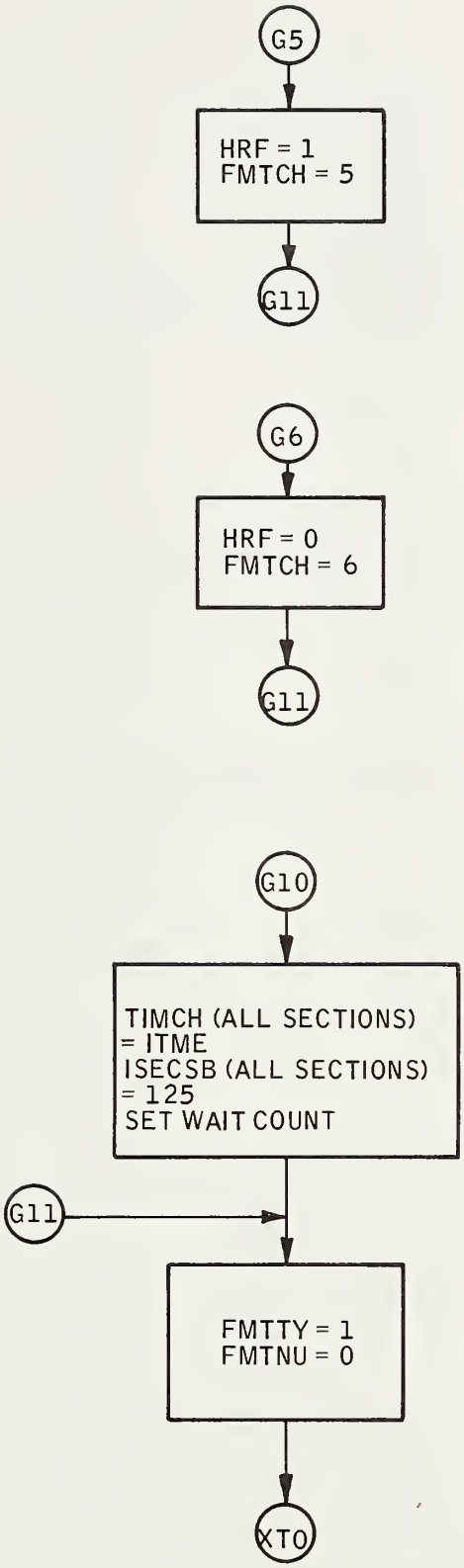

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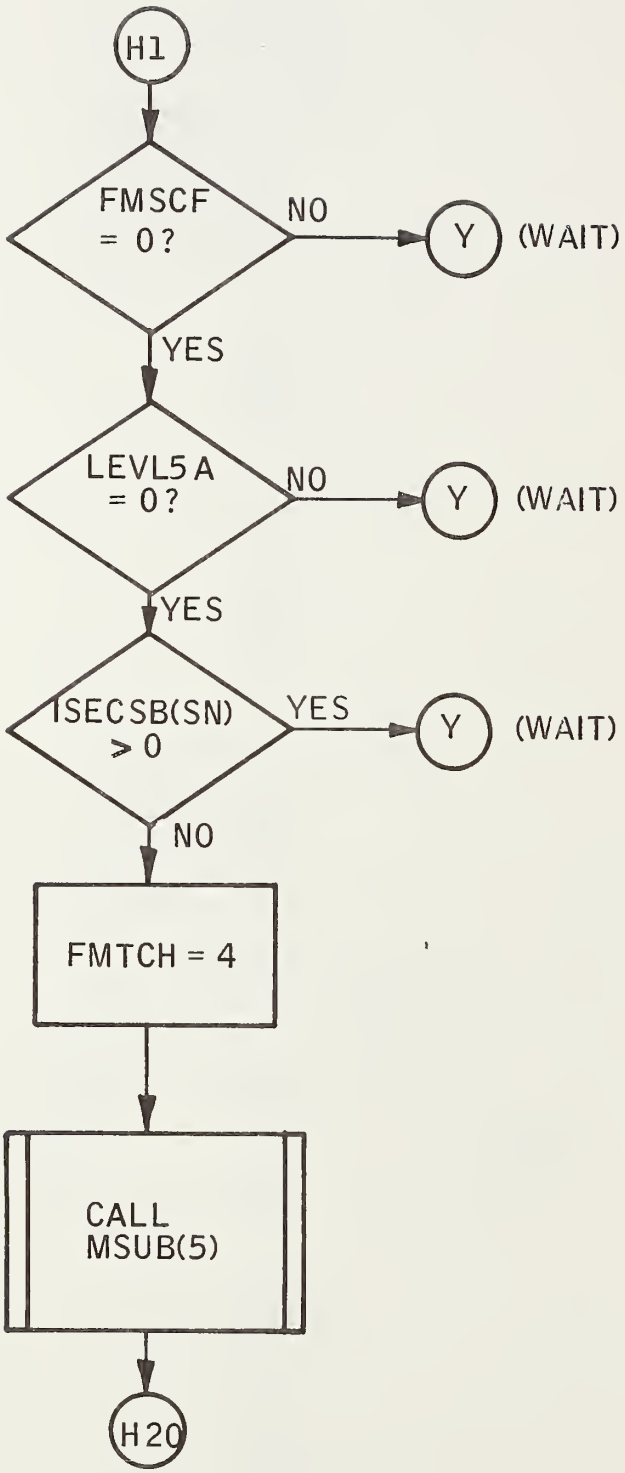

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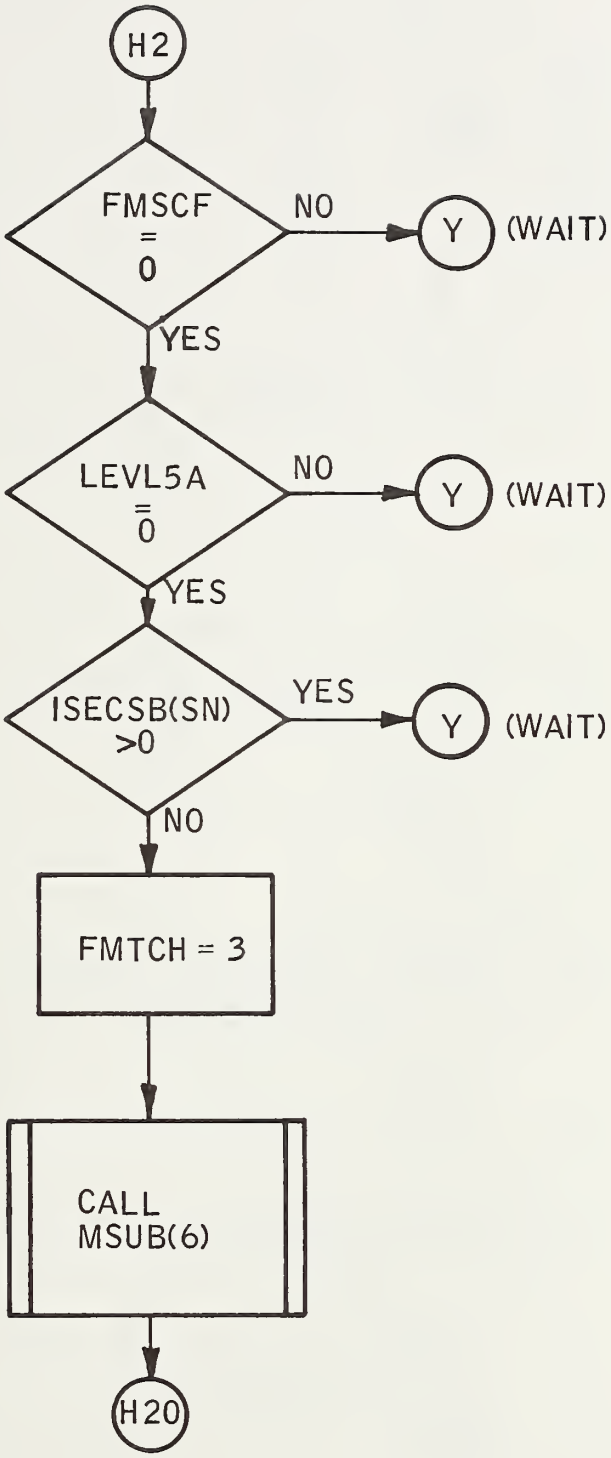

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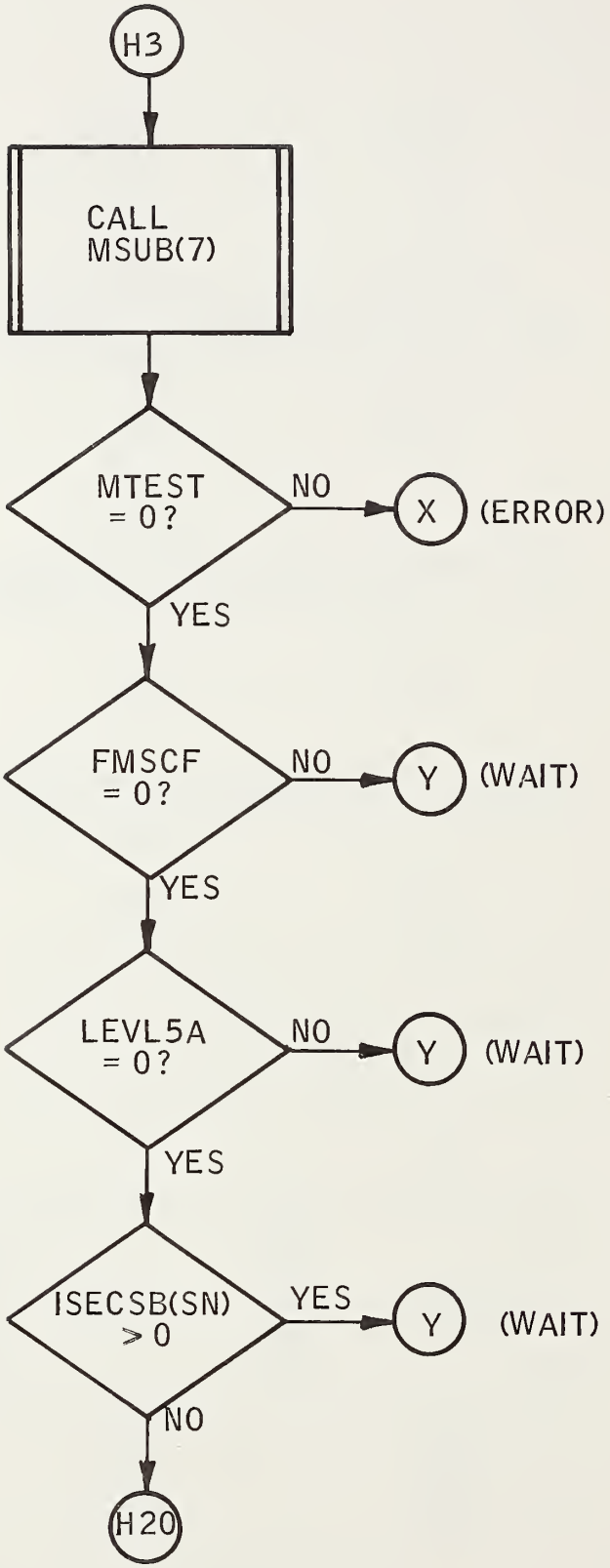

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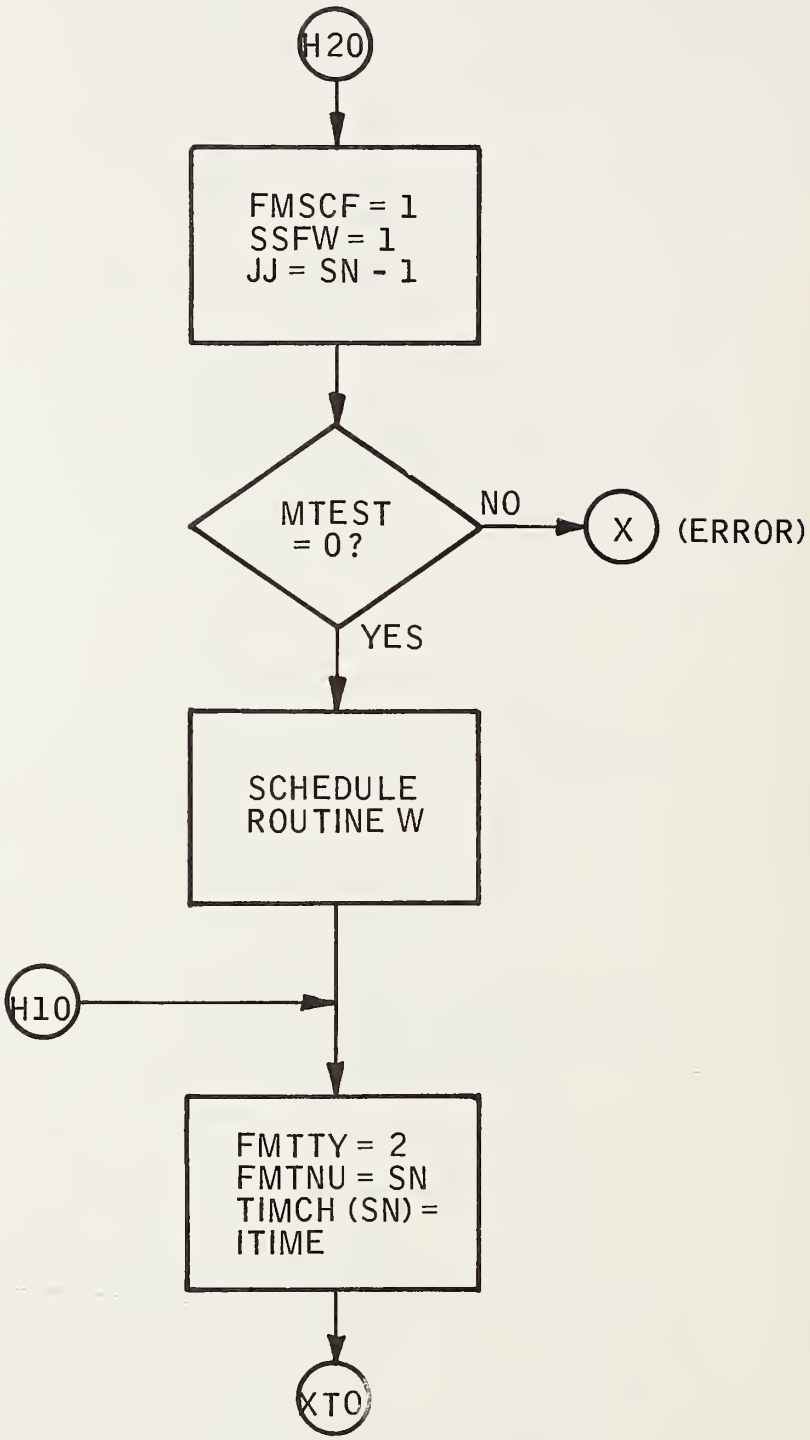
Routine M (Continued)



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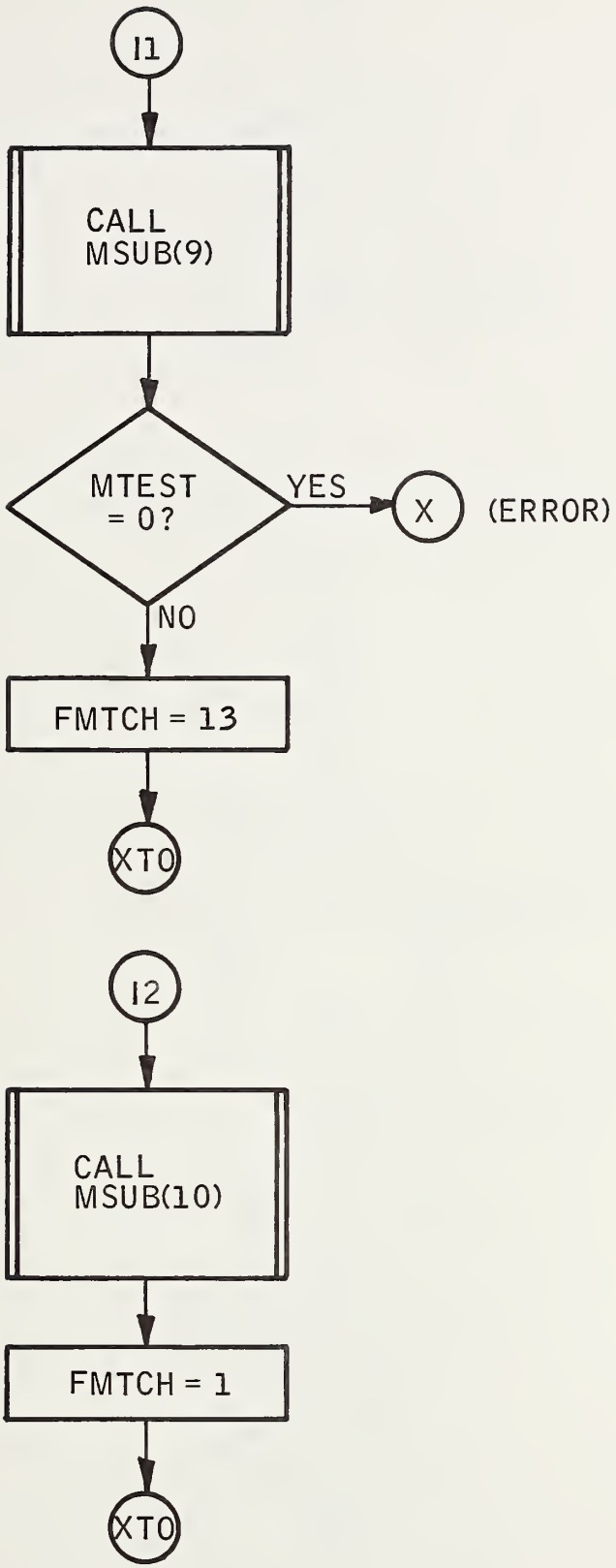

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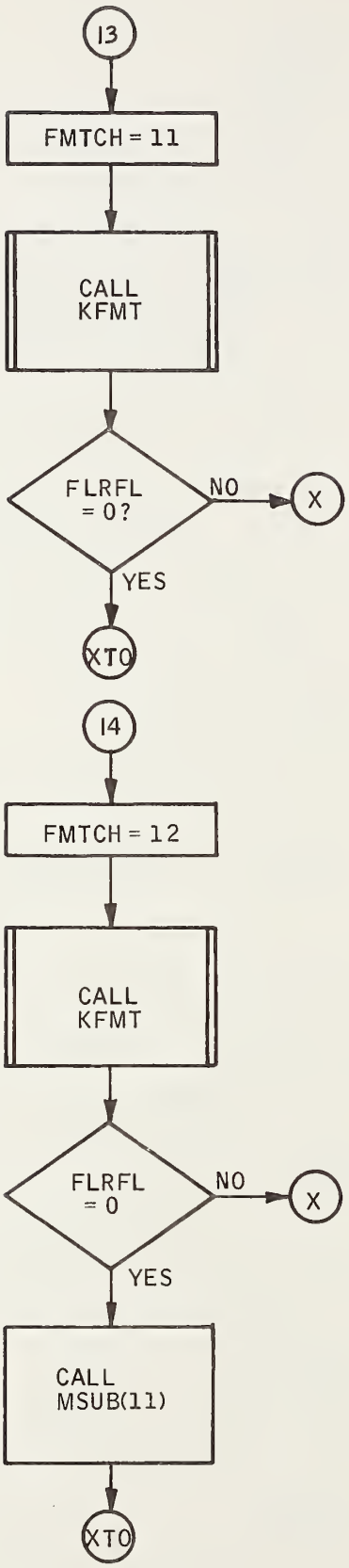

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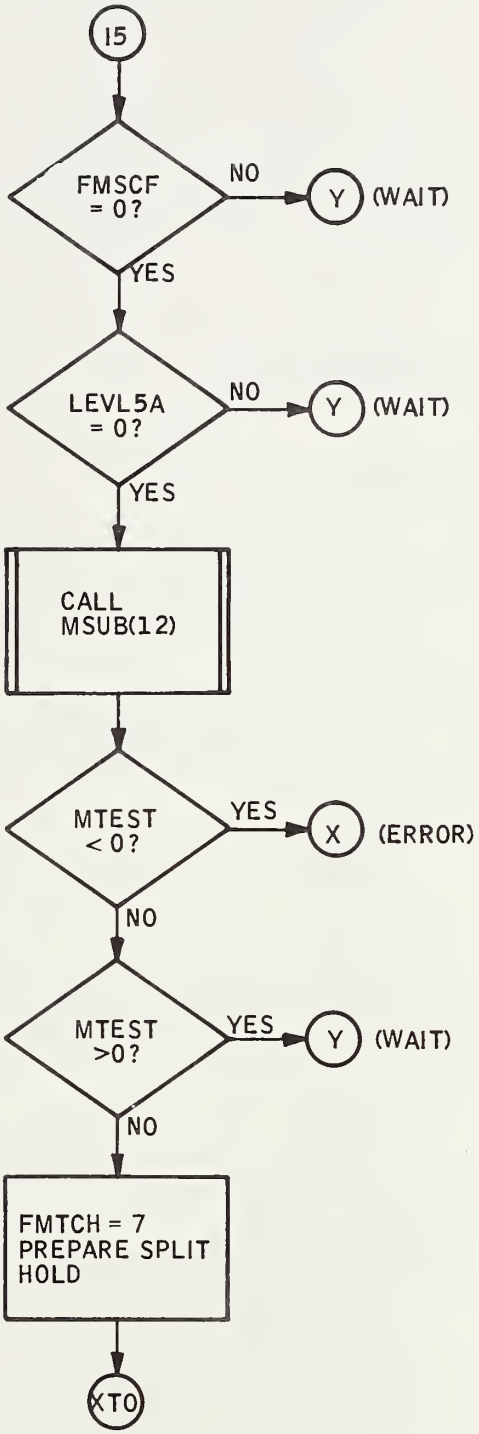

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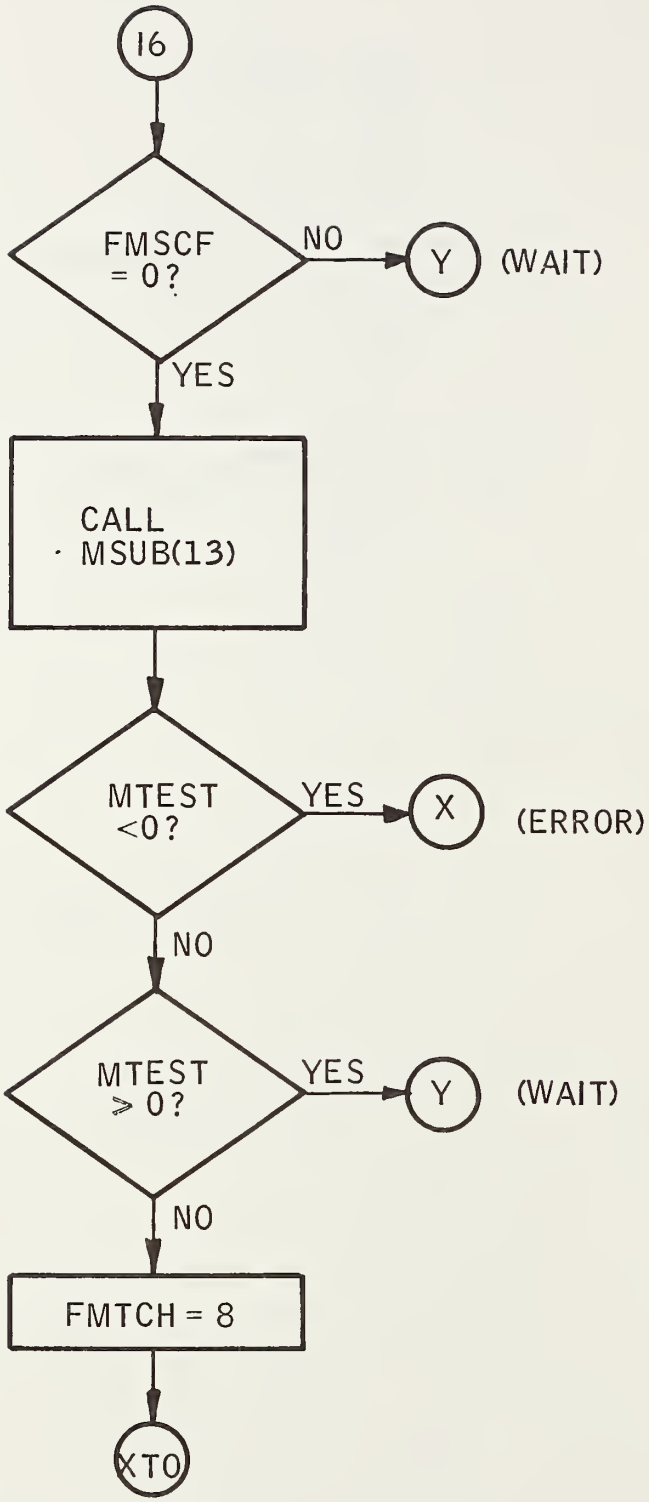

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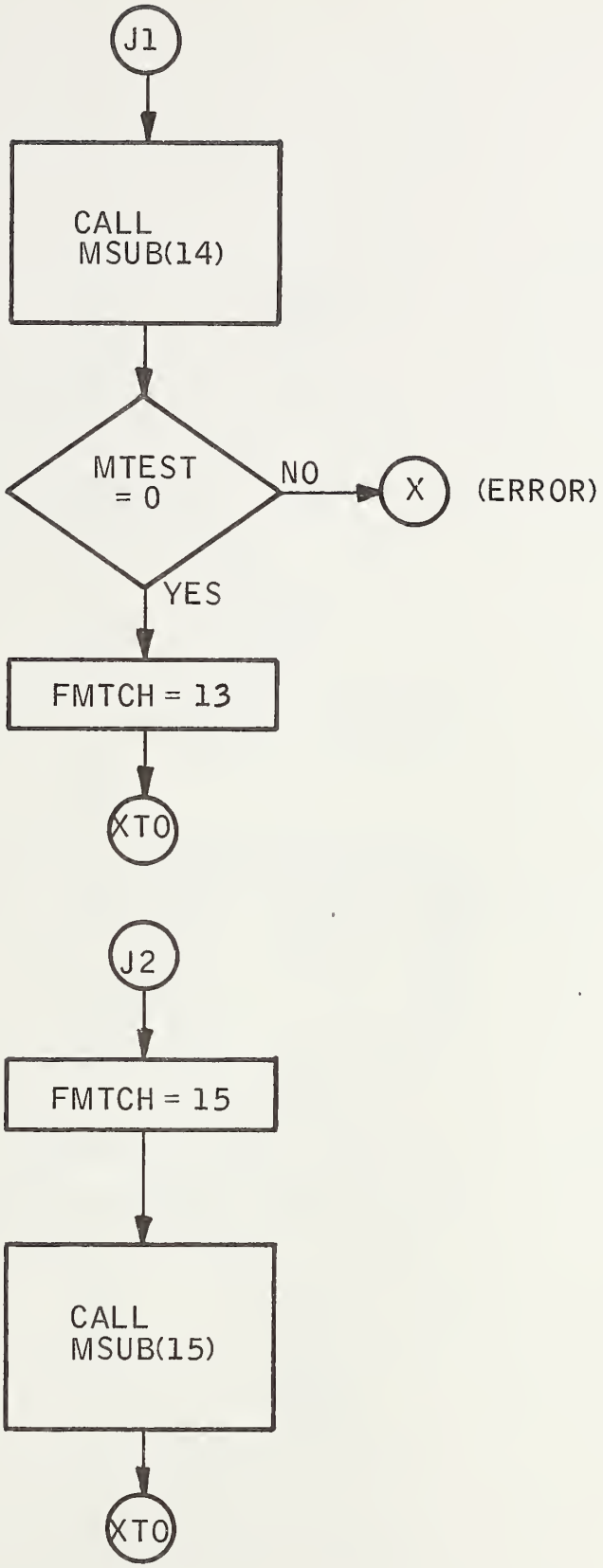

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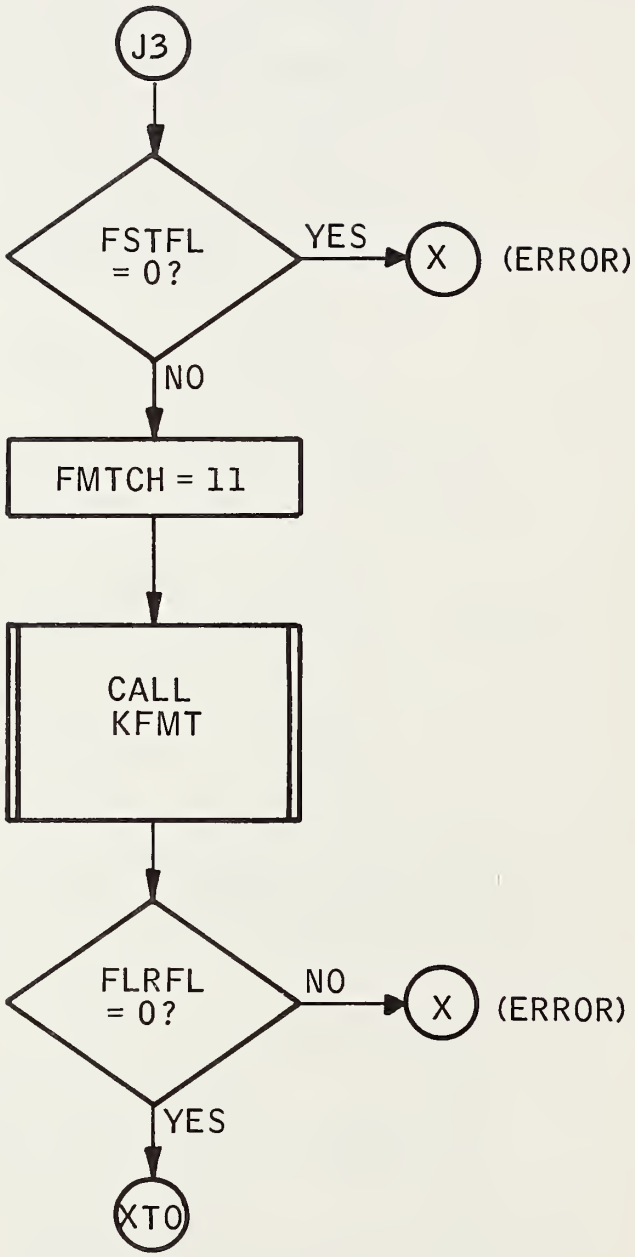

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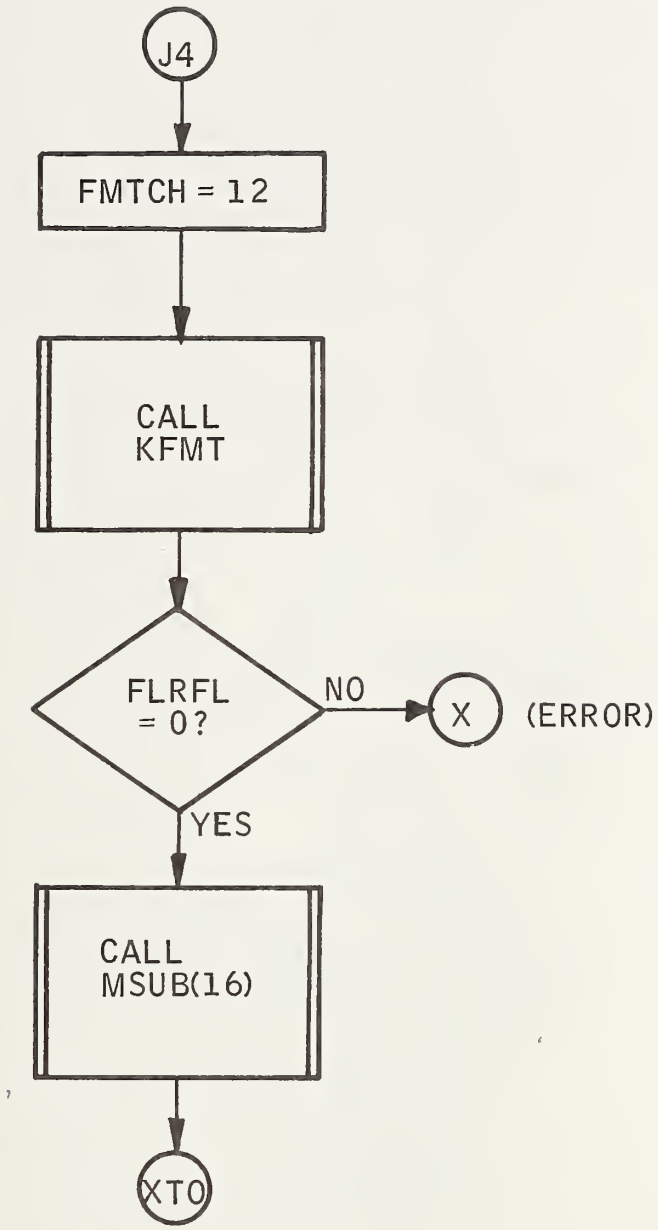

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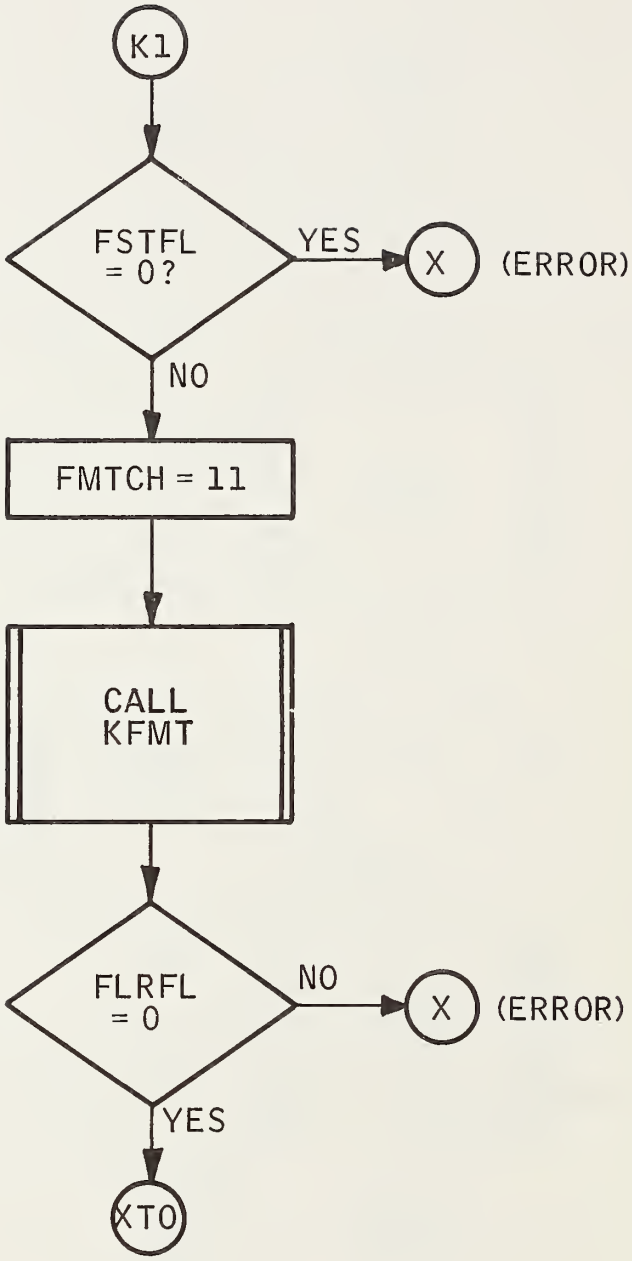

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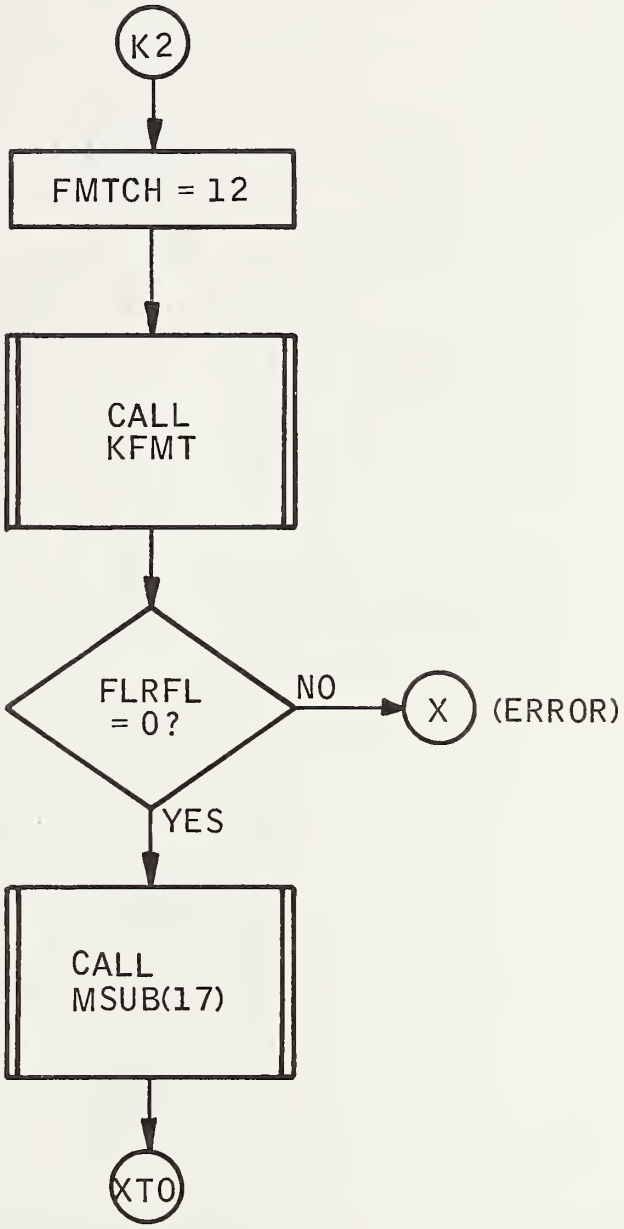

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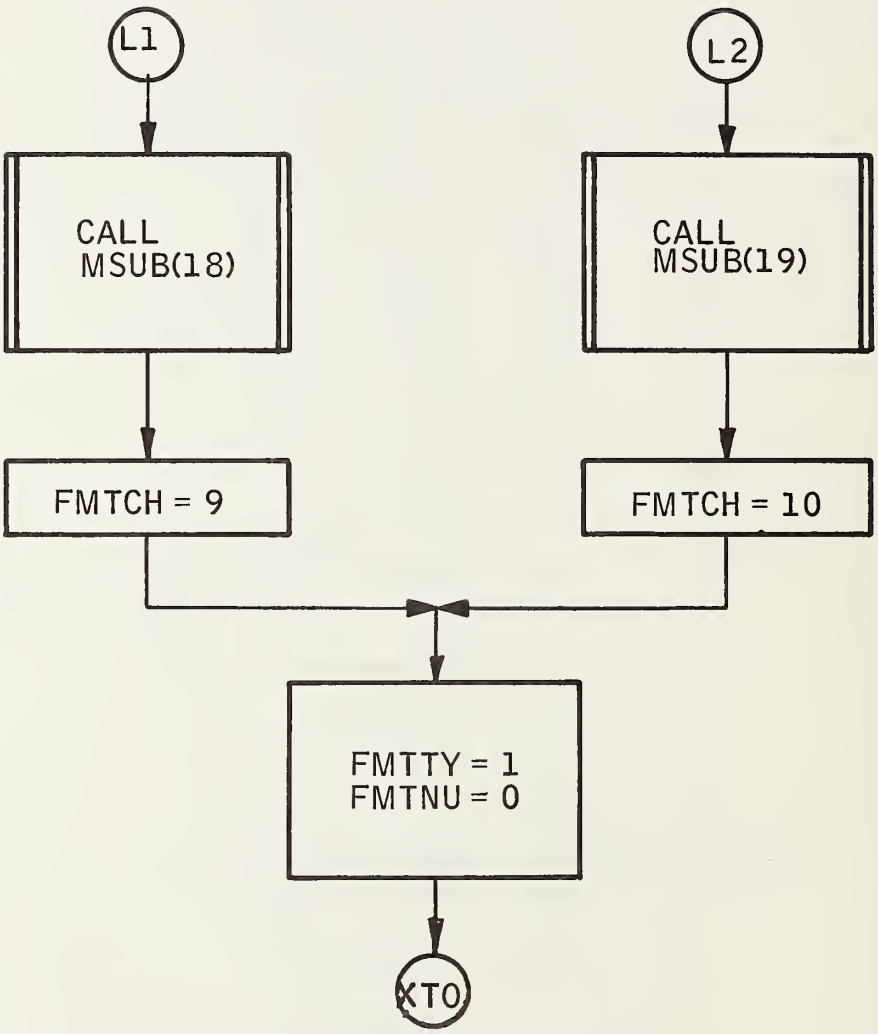

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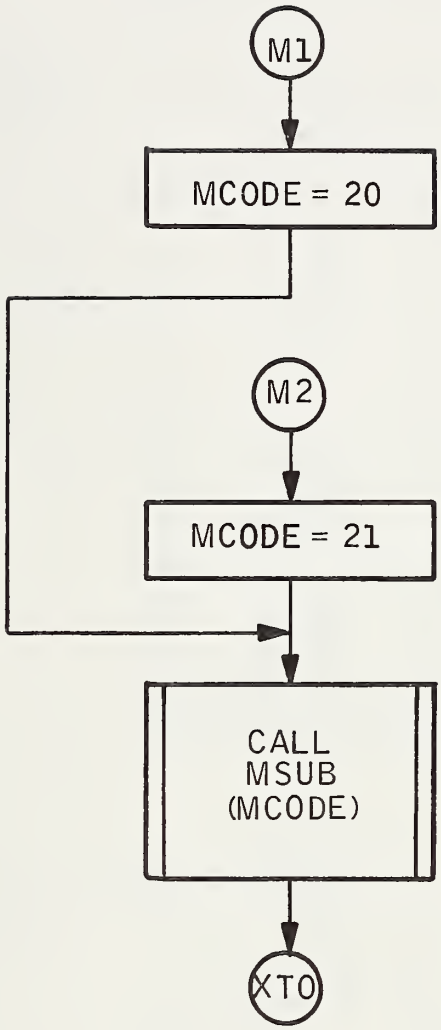

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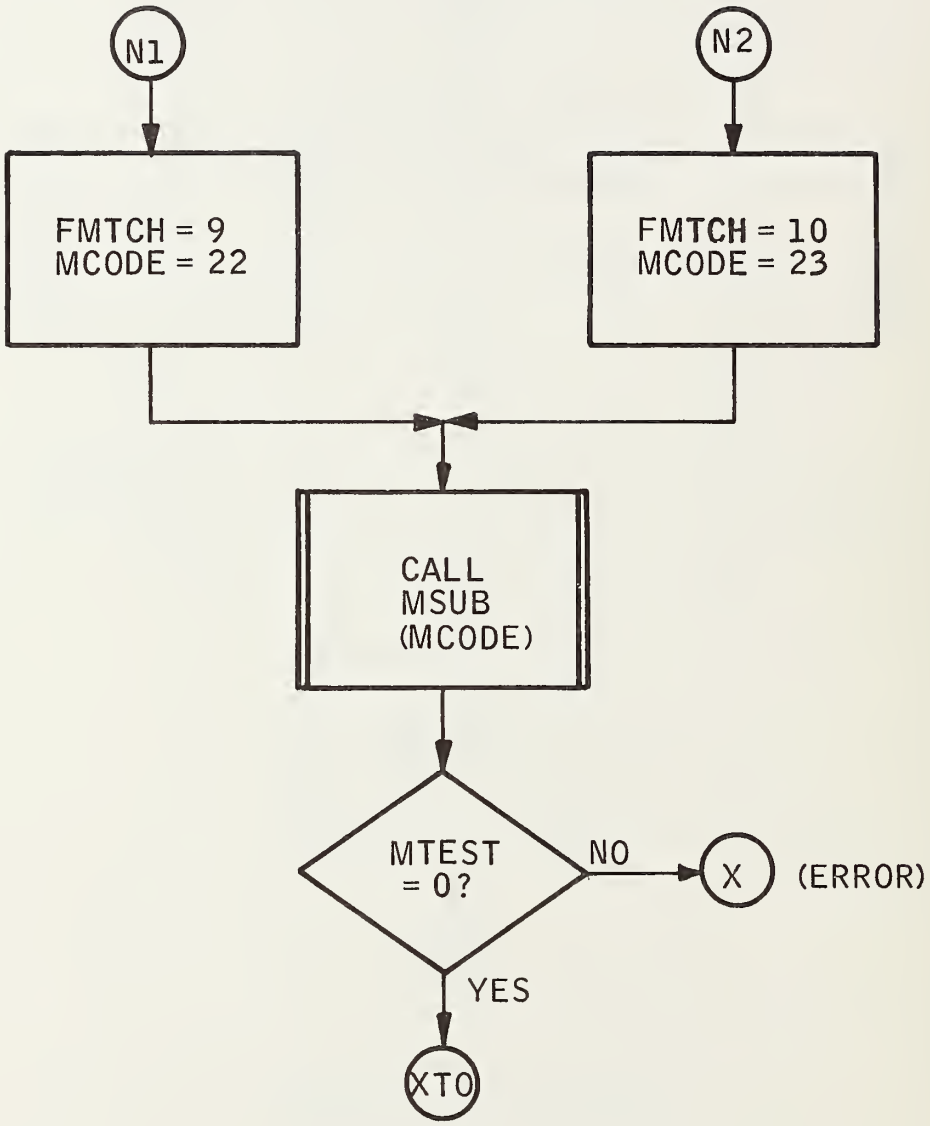

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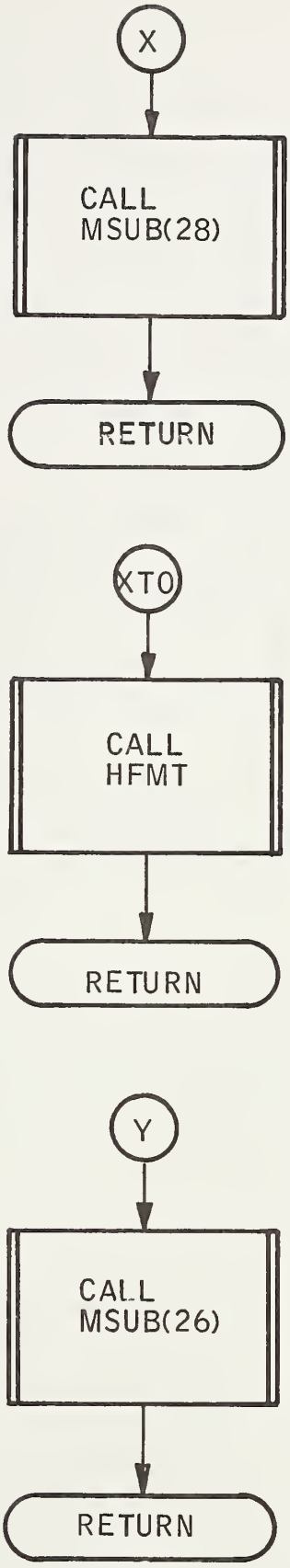


Routine M (Continued)

Routine M (Concluded)

2.6.52 SUBROUTINE HFMT

2.6.52.1 Purpose

This subroutine changes table formatting.

2.6.52.2 Relationship

This subroutine is called from Routine M by:

```
CALL HFMT
```

This subroutine calls E1SRT, HALF, PTHLF.

2.6.52.3 Assumption

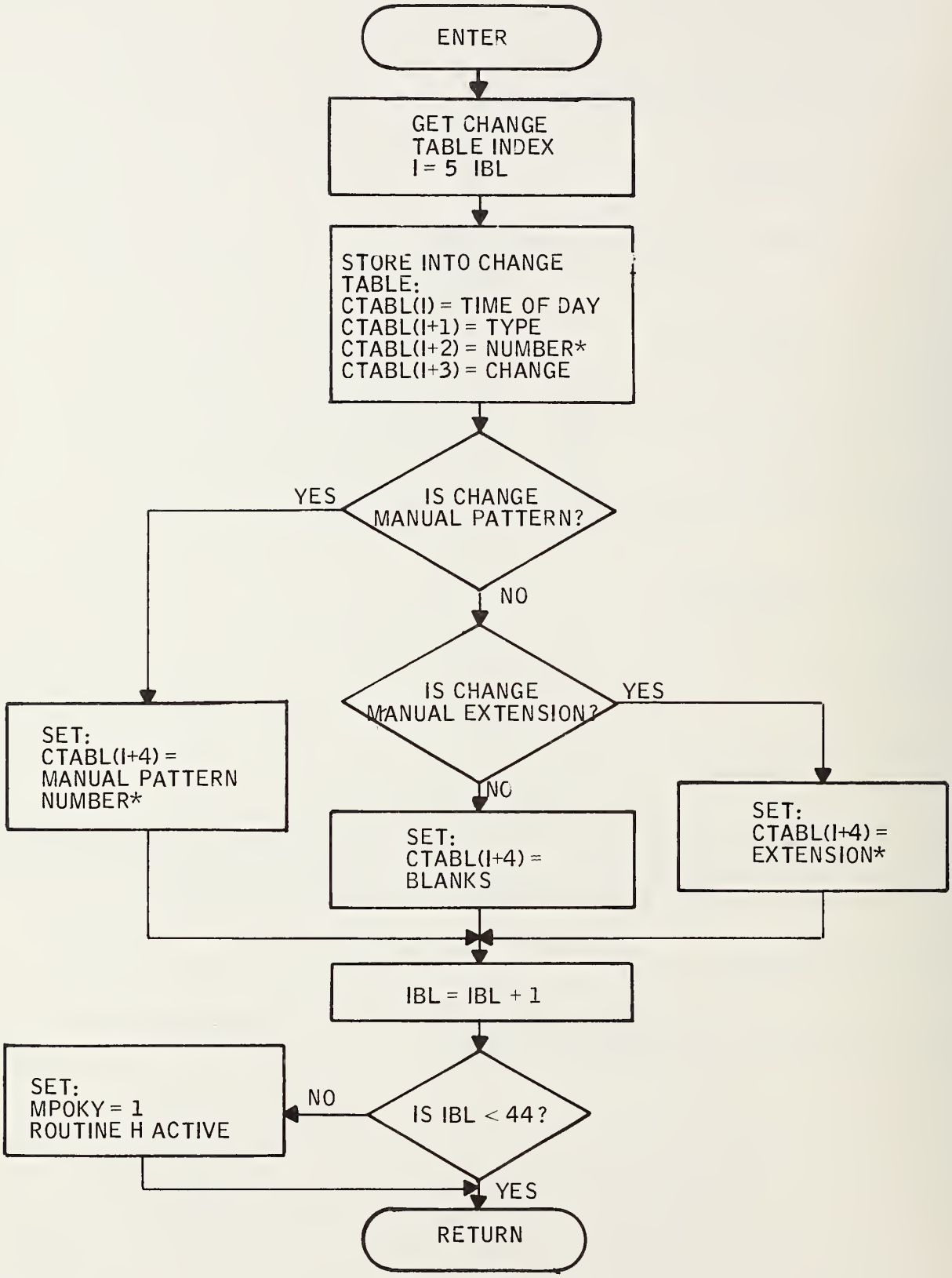
None.

2.6.52.4 Approach

Subroutine HFMT records the time of day, type of change, previous pattern number, and new pattern number following a change of pattern.

2.6.52.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine HFMT

2.6.53 SUBROUTINE KFMT

2.6.53.1 Purpose

This subroutine updates the failure table according to the change code contained in global variable FMTCH.

2.6.53.2 Relationship

Subroutine KFMT is called from Routine M by:

```
CALL KFMT
```

It returns to the calling routine.

2.6.53.3 Assumption

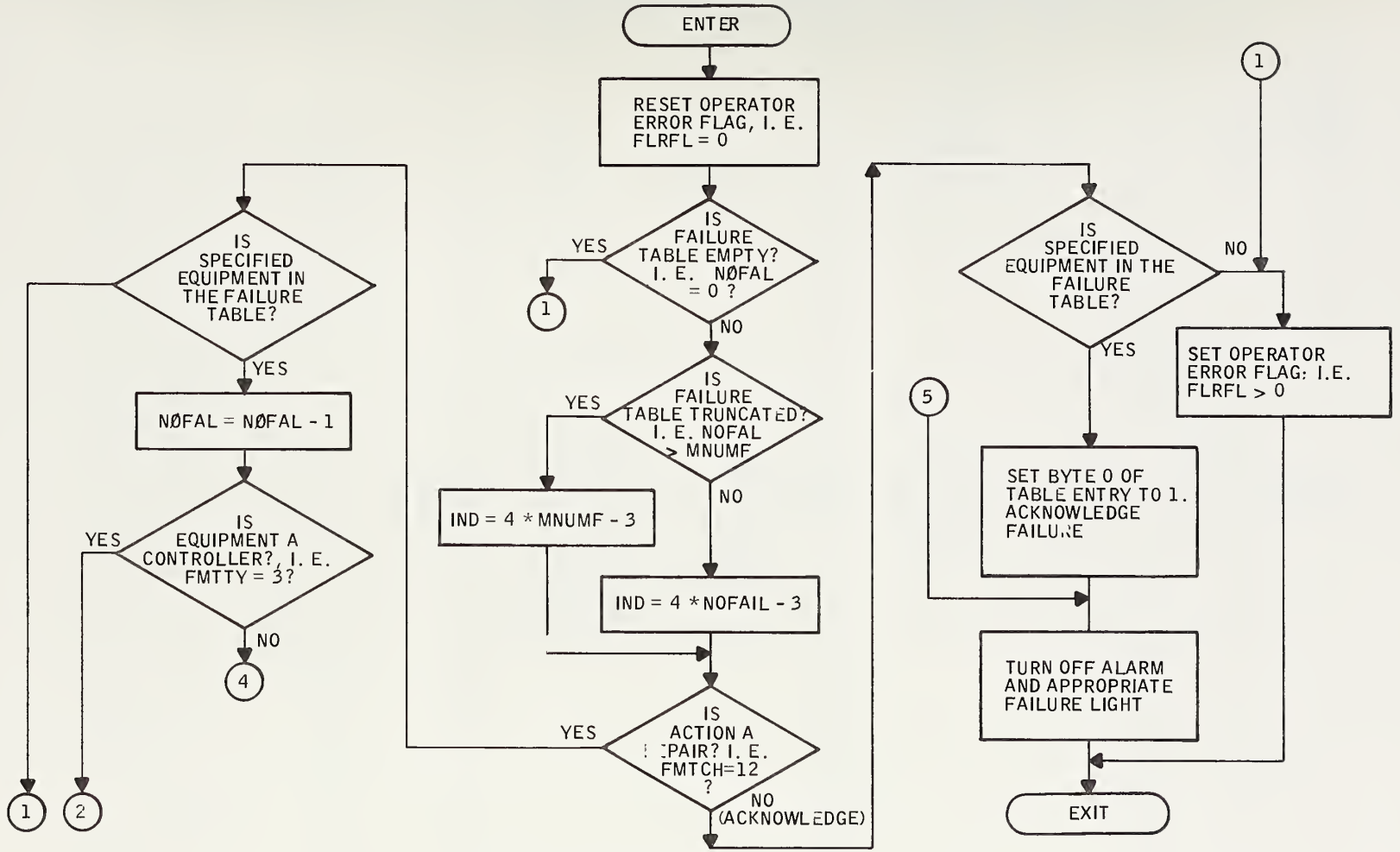
None.

2.6.53.4 Approach

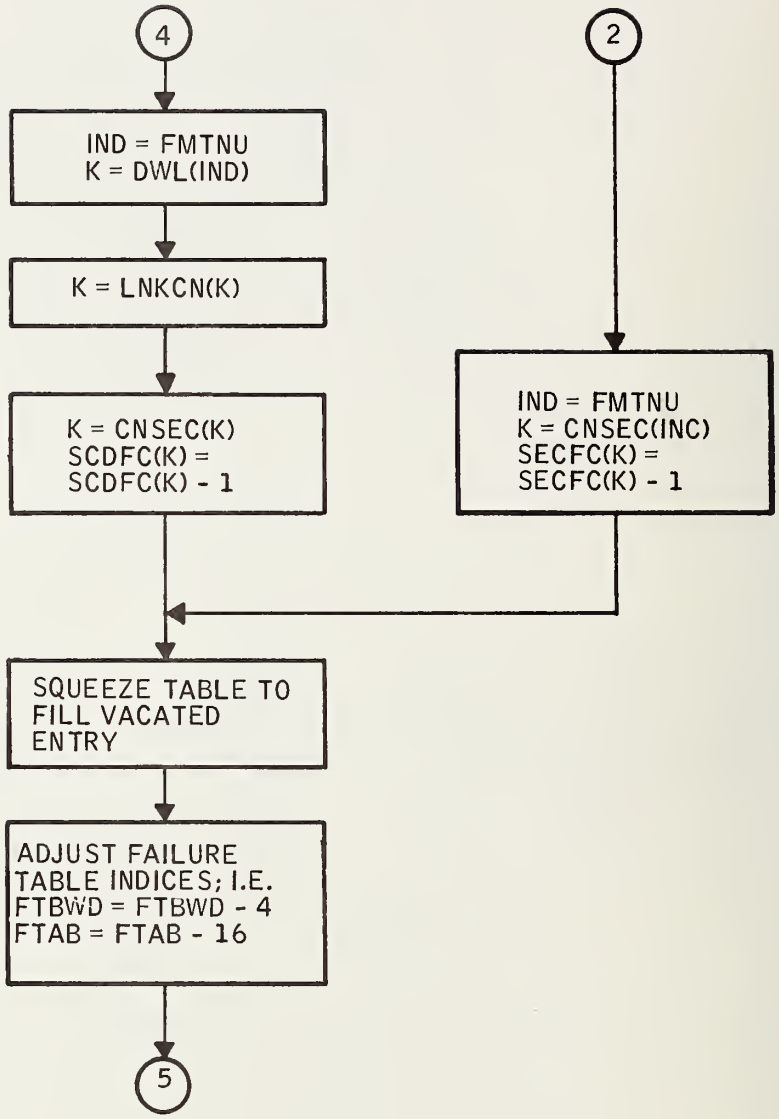
Subroutine KFMT updates the Failure Table according to the Change Code (V) contained in global variable FMTCH. If V specifies a failure acknowledge (V = 11) indicating that the operator wishes to acknowledge the failure of the equipment designated by T and U, KFMT sets the acknowledge status indicator to one (YES) in the appropriate entry of the Failure Table, turns off the appropriate malfunction indicator on the Control Panel and turns off the audible alarm. The other possible value of V (V = 12) specifies a failure repair. KFMT then deletes the appropriate entry in the Failure Table and reduces the sectional equipment and total system failure counts by one. In both cases, KFMT determines the equipment Type (T) from global variable FMTTY (= 3 for controller, = 4 for detector, = 5 for communications) and the identification number (U) from FMTNU. If no failure has been recorded in the Failure Table for the designated equipment, KFMT sets the Failure Error Flag non-zero (global variable FLRFL) to sign an illegal request.

2.6.53.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine KFMT



Subroutine KFMT (Concluded)

2.6.54 SUBROUTINE MSUB

2.6.54.1 Purpose

Subroutine MSUB packs and unpacks data from bit and byte arrays for processing by the FORTRAN Routine M.

2.6.54.2 Relationship

This subroutine is called from Routine M by:

```
CALL MSUB
```

The calling parameter is the variable MCODE which is passed through COMMON.

2.6.54.3 Assumption

None.

2.6.54.4 Approach

This subroutine is called from Routine M and is therefore not required to be re-entrant.

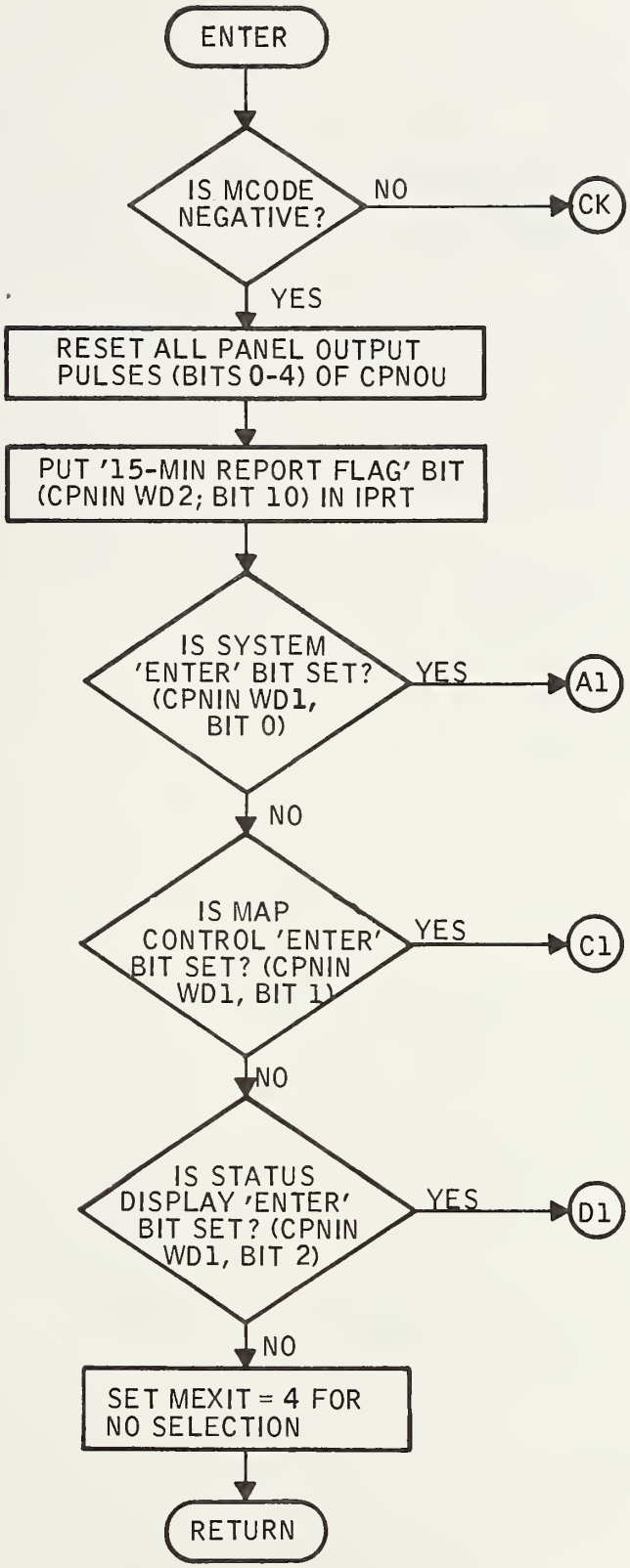
The flag MCODE, set in Routine M, is negative for the initial call and positive for subsequent calls.

For the initial pass, the first three bits of the Control Panel Input Array CPNIN determine selection of System Control, Map Control, or Status Display. MEXIT is set to indicate which branch was selected. The appropriate bits are unpacked from the CPNIN array and placed in the MBIT array.

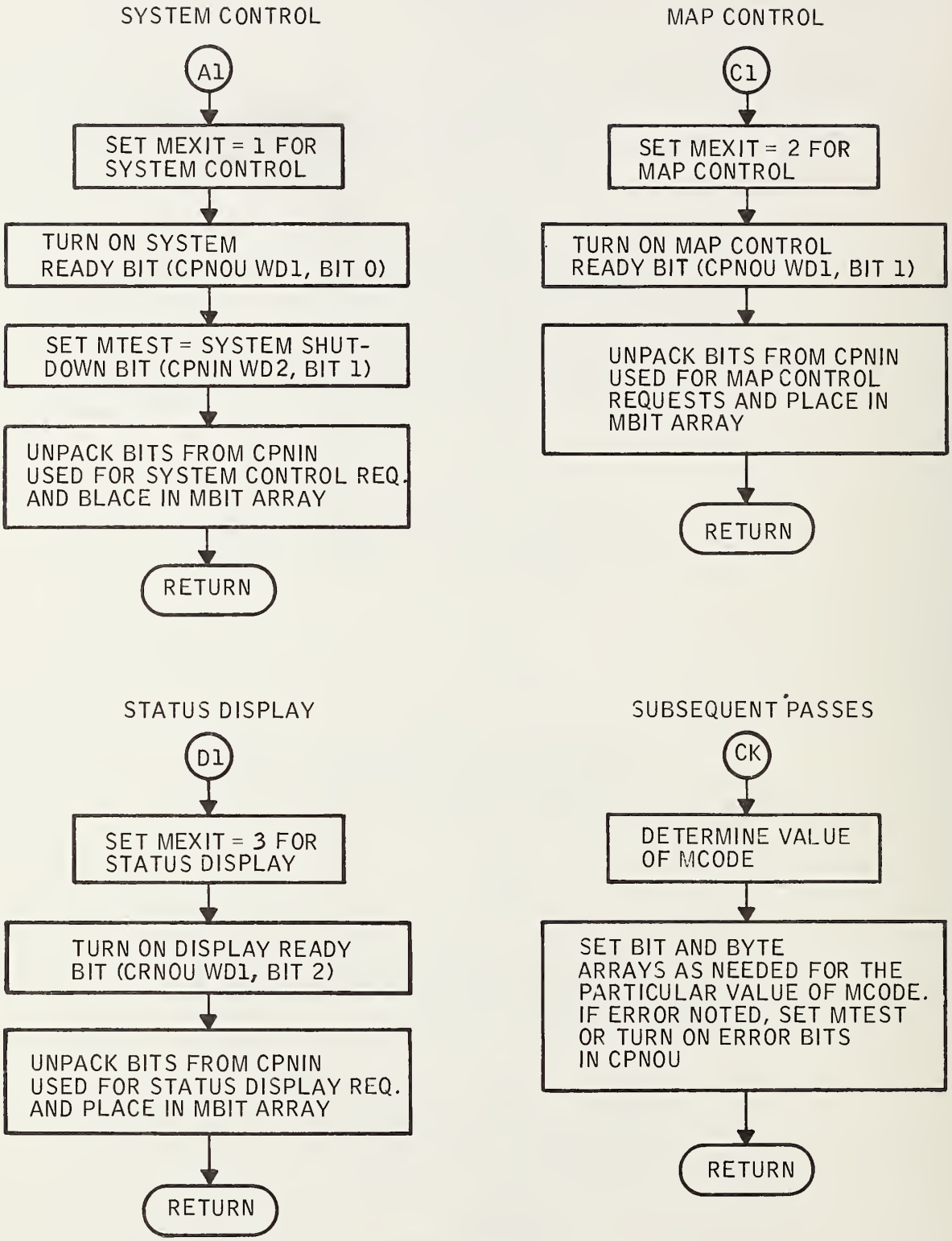
For subsequent passes, the value of MCODE determines what data are stored into bit and byte arrays. If an error condition is found in the data, MTEST is set to indicate this.

2.6.54.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine MSUB


SYSTEM CONTROL
A1
SET MEXIT = 1 FOR SYSTEM CONTROL
TURN ON SYSTEM READY BIT (CPNOU WD1, BIT 0)
SET MTEST = SYSTEM SHUT-DOWN BIT (CPNIN WD2, BIT 1)
UNPACK BITS FROM CPNIN USED FOR SYSTEM CONTROL REQ. AND BLACE IN MBIT ARRAY
RETURN
MAP CONTROL
C1
SET MEXIT = 2 FOR MAP CONTROL
TURN ON MAP CONTROL READY BIT (CPNOU WD1, BIT 1)
UNPACK BITS FROM CPNIN USED FOR MAP CONTROL REQUESTS AND PLACE IN MBIT ARRAY
RETURN
STATUS DISPLAY
D1
SET MEXIT = 3 FOR STATUS DISPLAY
TURN ON DISPLAY READY BIT (CRNOU WD1, BIT 2)
UNPACK BITS FROM CPNIN USED FOR STATUS DISPLAY REQ. AND PLACE IN MBIT ARRAY
RETURN
SUBSEQUENT PASSES
CK
DETERMINE VALUE OF MCODE
SET BIT AND BYTE ARRAYS AS NEEDED FOR THE PARTICULAR VALUE OF MCODE. IF ERROR NOTED, SET MTEST OR TURN ON ERROR BITS IN CPNOU
RETURN

Subroutine MSUB (Concluded)

2.6.55 ROUTINE MSUB2

2.6.55.1 Purpose

Data storage area. No executable code contained in this subroutine.

2.6.55.2 Relationship

Storage area. This subroutine is not called.

2.6.55.3 Assumption

None.

2.6.55.4 Approach.

Five words are reserved for data storage.

2.6.55.5 Listing

See Volume III, 2GCF Routine Listings.

2.6.56 SUBROUTINE SRCFT

2.6.56.1 Purpose

Subroutine SRCFT searches for failure table entry to be updated.

2.6.56.2 Relationship

This subroutine is called from subroutine KFMT by:

```
CALL SRCFT (INDEX, IRTN)
```

where:

INDEX = Index of fail table entry

IRTN = 0 Execute next statement after call (error return)

= 1 Jump 2 statements after call and begin execution for normal return

This subroutine calls HALF, GETBY.

2.6.56.3 Assumption

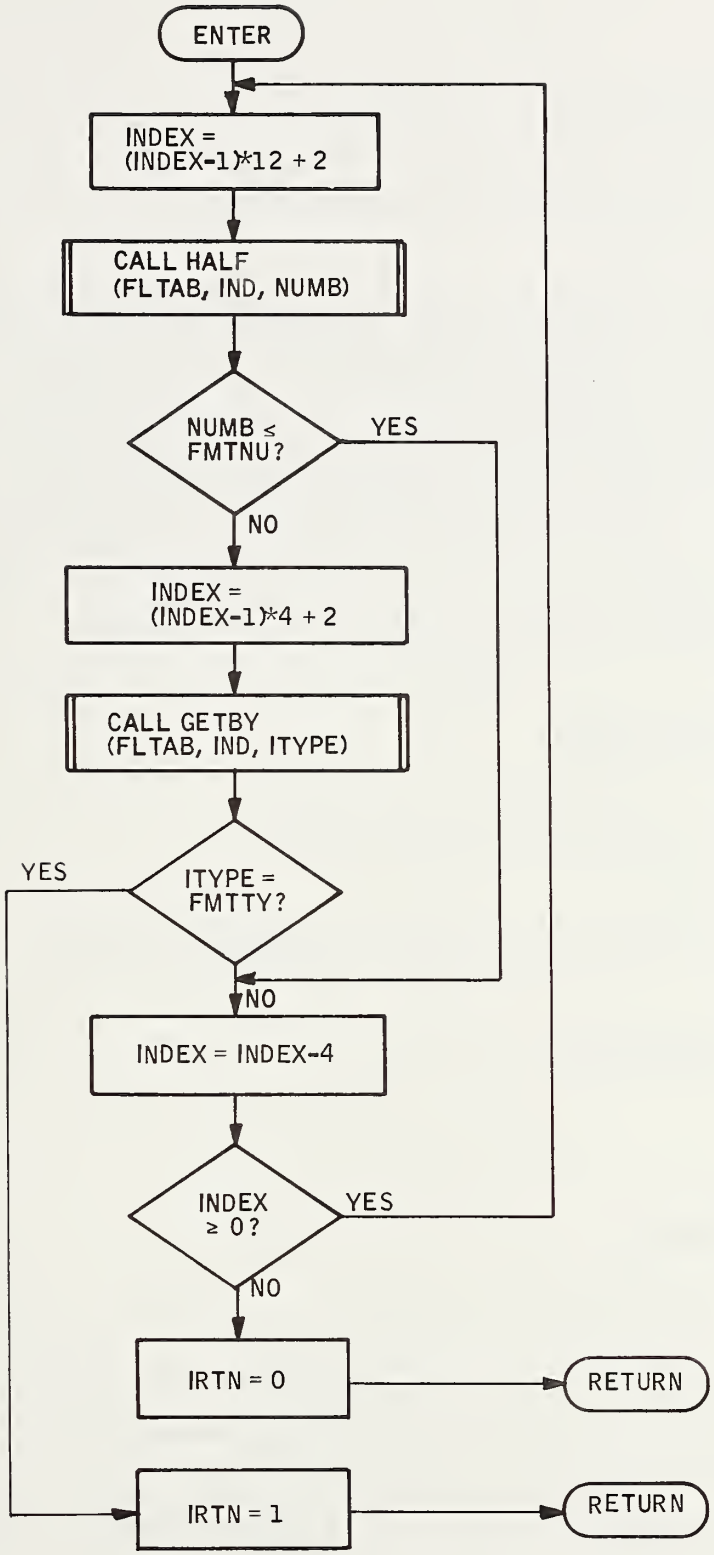
None.

2.6.56.4 Approach

Subroutine SRCFT searches the failure table to find an entry by equipment number (FMTNU) and type (FMTTY). If the device is found, SRCFT sets IRTN to 0 and INDEX to the location in the failure table where the device's failure was recorded. If the device is not found IRTN is set to 1. SFCFT returns to the calling routine.

2.6.56.5 Listing

See Volume III, 2GCF Routine Listings.



Routine SRCFT

2.6.57 ROUTINE O

2.6.57.1 Purpose

The purpose of Routine O is to set A-Phase Green indication bits in word AOG, and start of A-Phase Green bits in word STRTA, for each local controller. This routine is executed once per second for all local controllers. The routine is processed immediately following Routine N and exits to Routine A1. It also calls UNPO and PCKO to unpack and pack bit arrays that are required by Routine O. UNPO unpacks bit arrays GAI, STRTA, and AOG, PCKO packs bit arrays STRTA and AOG.

2.6.57.2 Relationship

Routine O is called from Routine A1 by:

```
CALL RTNO
```

Routine O calls subroutines UNPO and PCKO.

2.6.57.3 Assumption

None.

2.6.57.4 Approach

Upon entry every second, a Do-Loop is set up in which 32 controllers are processed at one time. For each controller, the routine subsequently computes the corrected A-Phase Green Return word (AOG) and start of A-Phase Green (STRTA). This is accomplished by first storing into GAP1, the ones complement of A-Phase Green Return input word GAI. The input data must be complemented since the MUX supplies the data to the computer in complemented form. GAP1 points to alternate input array labels GA1 or GA2

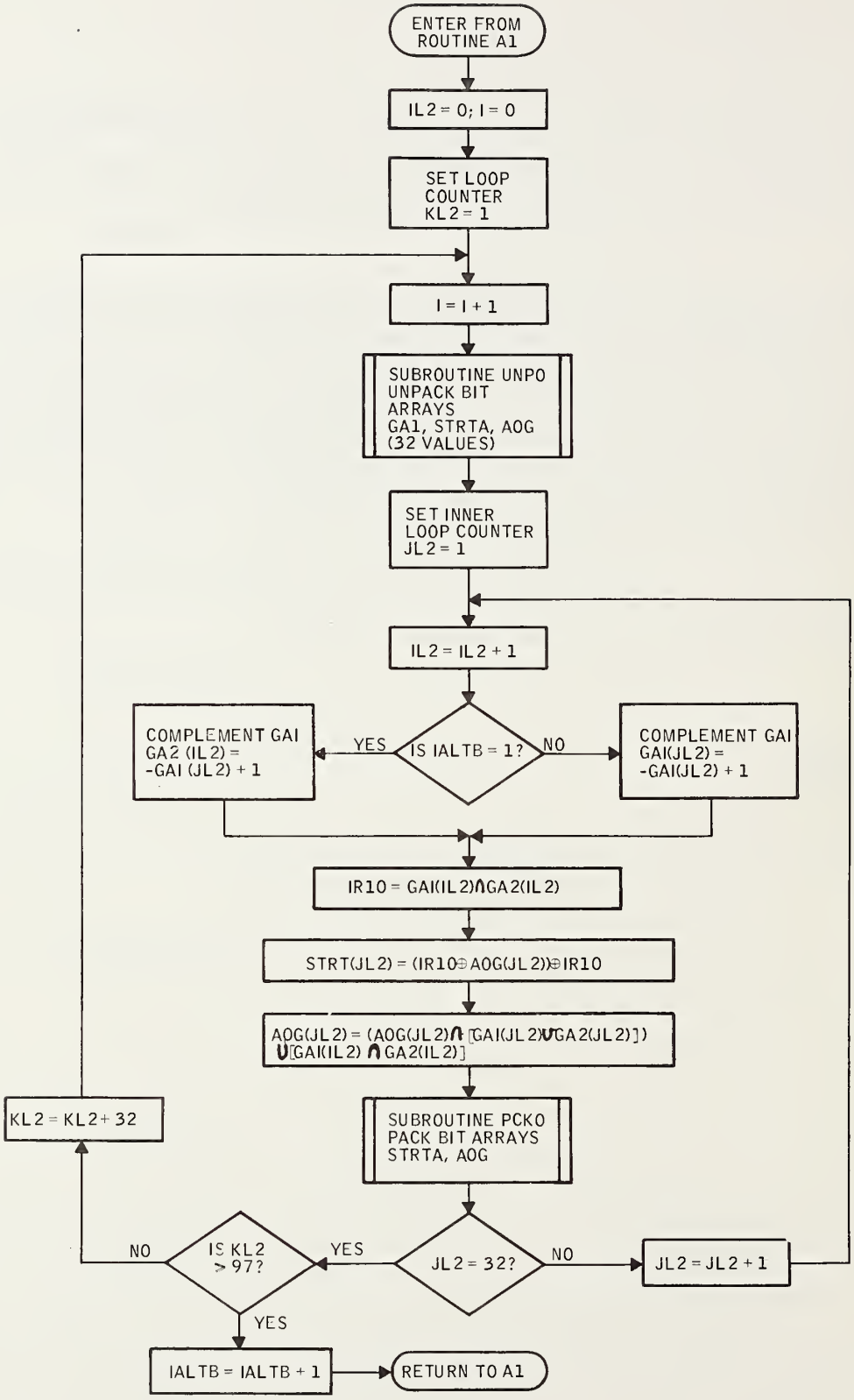
and is initially set to label GA1. In location GT, the result of the boolean operation GA1∩GA2 is stored for word AWI. The start of A-Phase Green is computed using the boolean operation AOG∩(GA1∩GA2).

After computing STRTA, AOG is calculated. The algorithm used sets AOG to a one if the signal was present for two pulses in a row, i.e., GA1 and GA2 are both a one. It also sets AOG to a zero if the signal was absent for two pulses in a row. Otherwise, AOG remain unchanged. This has the effect of removing a single noise pulse where no signal is present and filling in a single missing pulse when the signal is present.

Upon completion of all controller words, the label in GAP1 is interchanged to the alternate buffer label, and the routine is exited.

2.6.57.5 Listing

See Volume III, 2GCF Routine Listings.


ENTER FROM ROUTINE A1
IL2 = 0; I = 0
SET LOOP COUNTER KL2 = 1
I = I + 1
SUBROUTINE UNPO UNPACK BIT ARRAYS GA1, STRTA, AOG (32 VALUES)
SET INNER LOOP COUNTER JL2 = 1
IL2 = IL2 + 1
COMPLEMENT GAI GA2 (IL2) = -GAI (JL2) + 1
YES
IS IALTB = 1?
NO
COMPLEMENT GAI GAI(JL2) = -GAI(JL2) + 1
IR10 = GAI(IL2)∩GA2(IL2)
STRT(JL2) = (IR10⊕AOG(JL2))⊕IR10
AOG(JL2) = (AOG(JL2)∩[GAI(JL2)∪GA2(JL2)]) ∪[GAI(IL2) ∩GA2(IL2)]
KL2 = KL2+ 32
SUBROUTINE PCKO PACK BIT ARRAYS STRTA, AOG
NO
IS KL2 > 97?
YES
JL2 = 32?
NO
JL2 = JL2 + 1
YES
IALTB = IALTB + 1
RETURN TO A1

Routine O

2.6.58 SUBROUTINE PCKO

2.6.58.1 Purpose

This subroutine packs bits into STRTA and AOG.

2.6.58.2 Relationship

This subroutine is called from Routine O by:

```
CALL PKBIT
```

This subroutine calls subroutine PKBIT.

2.6.58.3 Assumption

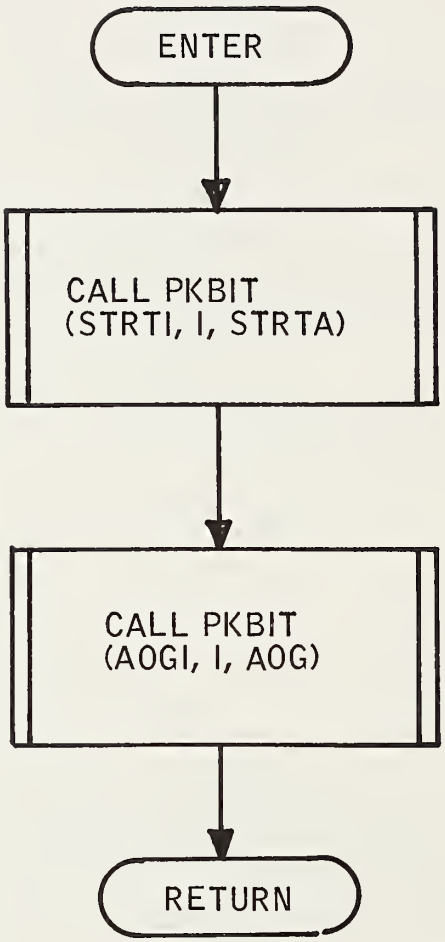
None.

2.6.58.4 Approach

Subroutine PCKO makes repeated calls to subroutine PKBIT to store AOGI and STRTI into the I bit of arrays AOG and STRTA, respectively. PCKO then returns to the calling routine. Variable I is passed through COMMON block PCOM.

2.6.58.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine PCKO

2.6.59 SUBROUTINE UNPO

2.6.59.1 Purpose

This subroutine unpacks GAII and AOGI.

2.6.59.2 Relationship

This subroutine is called from Routine O by:

```
CALL UNPO
```

This subroutine calls UNBIT.

2.6.59.3 Assumption

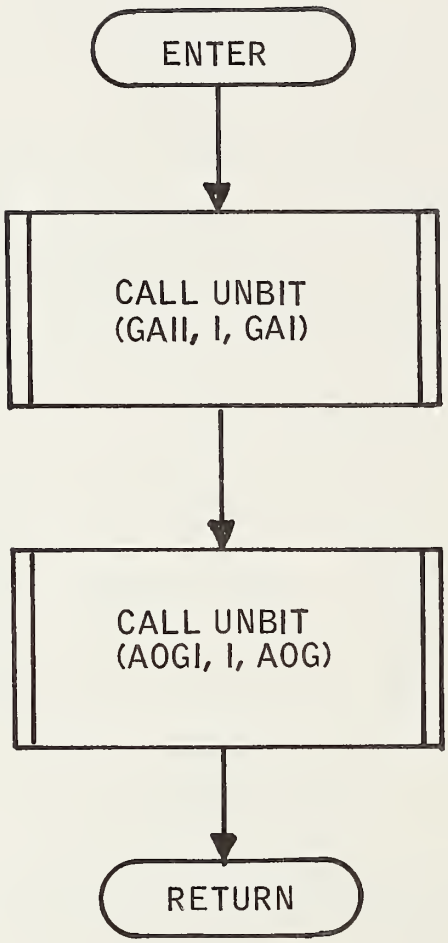
None.

2.6.59.4 Approach

Subroutine UNPO makes repeated calls to UNBIT to retrieve the I bit from the GAII and AOGI arrays. These are held in GAI and AOG, respectively. UNPO then returns to the calling routine. Variable I is passed through COMMON block PCOM.

2.6.59.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine UNPO

2.6.60 ROUTINE P

2.6.60.1 Purpose

Routine P scans the complement of controllers which have been flagged as being out of synchronization with the computer. If the controller is out of phase by one interval a correction is attempted, otherwise, the controller is dropped into stand-by. The routine is executed once per second for every controller out of phase.

2.6.60.2 Relationship

This routine is the first routine in the Controller Do-Loop and is executed at Priority Level 2. It is called by the Level 2 Executive. Routine P calls UNPP1 to unpack TIMEO and INTOU if they are required. It makes a call to UNPP2 if INTR2, INTNL, and INTRH are required. PACKP1 is called at the end of the routine to pack TIMEO and INTOU.

2.6.60.3 Assumption

None.

2.6.60.4 Approach

Routine P is the first routine in the Controller Do-Loop (defined in Routine A1, Do-Loop Routine) and is scheduled by the Do-Loop Routine whenever it determines there is a controller out of phase. Routine A1 checks if any current controllers being processed are out of sync. If so, Routine P is called to process eight controllers. This routine then scans to determine

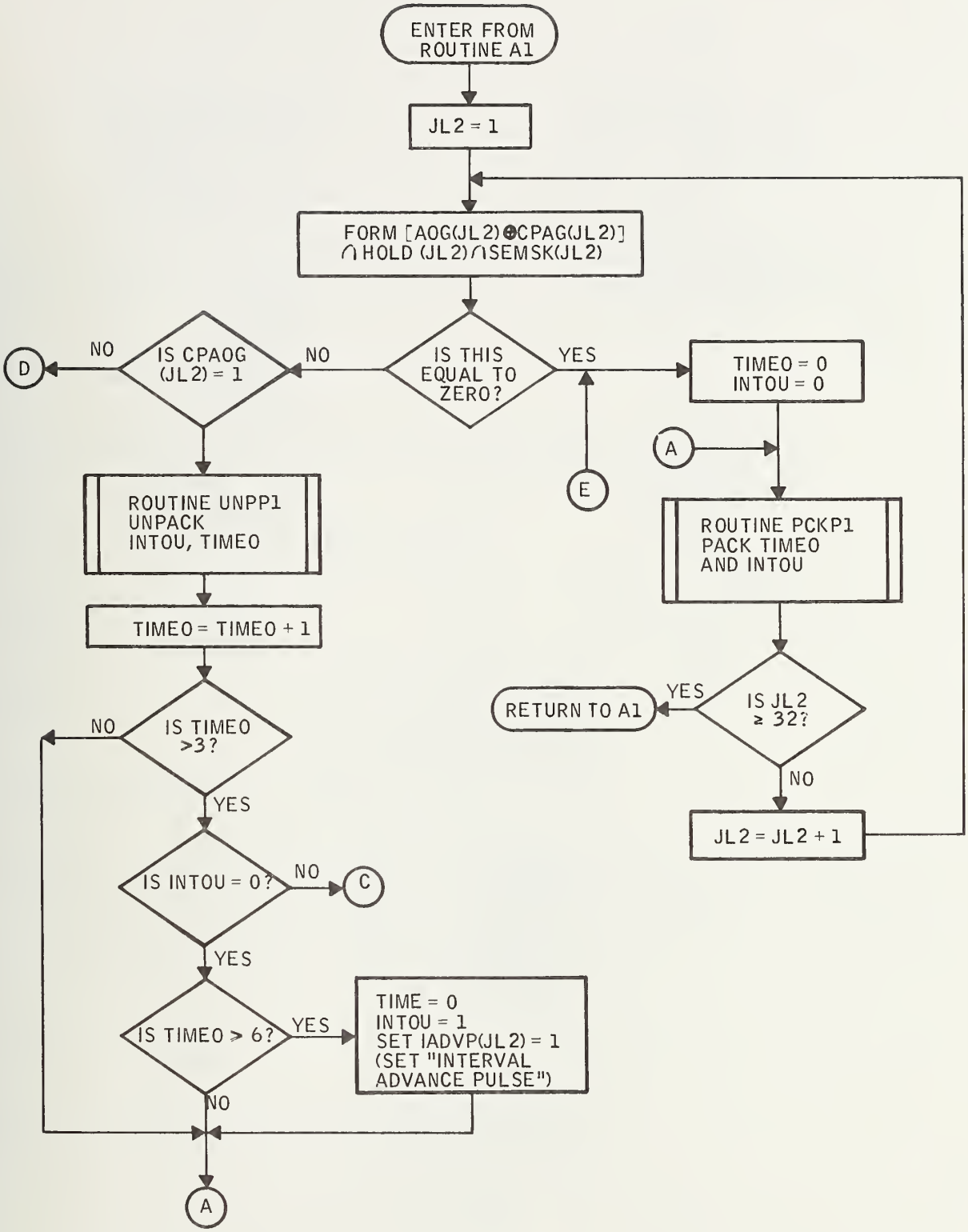
which controllers are out of sync. For each one detected, this routine determines if the corresponding controller is leading or lagging the computer.

If the controller is found to be lagging, a timeout procedure is initiated with a 3 second duration. If the controller is still lagging after timeout, an advance pulse is sent to the controller and a 1.5-second timeout is initiated. If the controller is still found to be lagging after this period, it is dropped to standby and the CRT Failure Table is appropriately updated.

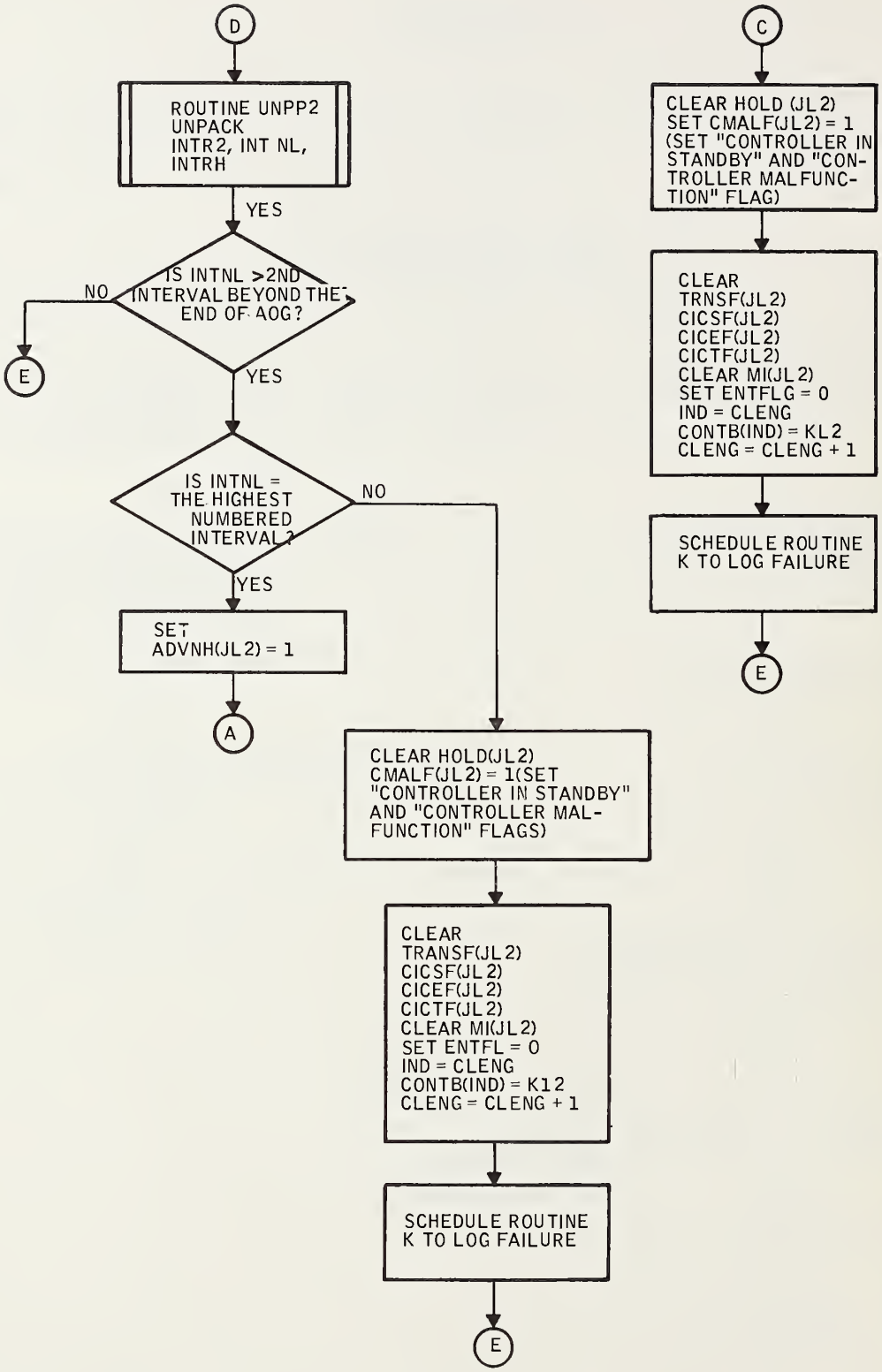
When a controller is found to be leading the computer a test is made to determine if it is more than one interval out of phase. If it is out of phase by more than one interval, it is dropped to standby. Otherwise the next advance pulse to the controller is inhibited.

2.6.60.5 Listing

See Volume III, 2GCF Routine Listings.


ENTER FROM ROUTINE A1
JL2 = 1
FORM [AOG(JL2)⊕CPAG(JL2)] ∩ HOLD (JL2) ∩ SEMSK(JL2)
IS THIS EQUAL TO ZERO?
YES
NO
TIMEO = 0
INTOU = 0
A
E
ROUTINE PCKP1
PACK TIMEO
AND INTOU
IS JL2 ≥ 32?
YES
RETURN TO A1
NO
JL2 = JL2 + 1
IS CPAOG (JL2) = 1
NO
D
ROUTINE UNPP1
UNPACK
INTOU, TIMEO
TIMEO = TIMEO + 1
IS TIMEO >3?
NO
YES
IS INTOU = 0?
NO
C
YES
IS TIMEO > 6?
YES
TIME = 0
INTOU = 1
SET IADVP(JL2) = 1
(SET "INTERVAL ADVANCE PULSE")
NO
A

Routine P



Routine P (Concluded)

2.6.61 SUBROUTINE PCKP1

2.6.61.1 Purpose

This subroutine packs bytes from WSLZ(7) and WSLZ(6) into TIMEI and INTOI, respectively.

2.6.61.2 Relationship

This subroutine is called from Routine P by:

```
CALL PCKP1
```

This subroutine calls routine PKBYT.

2.6.61.3 Assumption

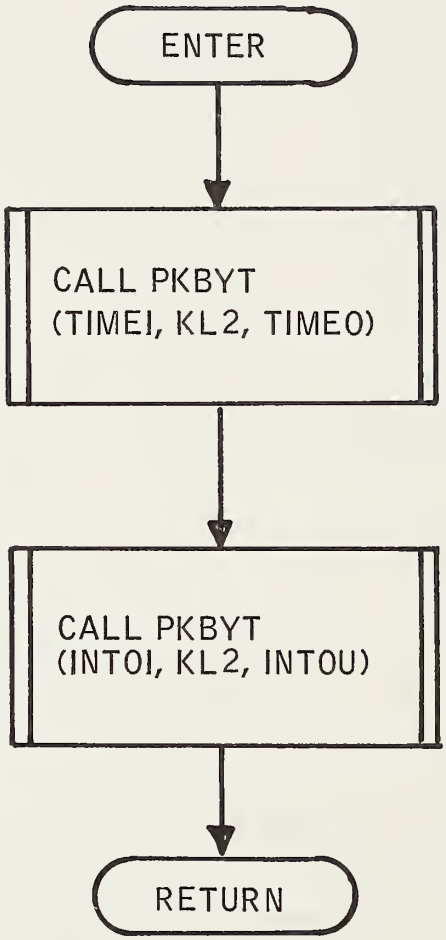
None.

2.6.61.4 Approach

Subroutine PCKP1 makes repeated calls to subroutine PKBYT to store WSLZ(7) and WSLZ(6) into the KLZ byte of TIMEI and INTOI, respectively. PCKP1 then returns to the calling routine. Variable KLZ is passed through COMMON block BYTLZ.

2.6.61.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine PCKP1

2.6.62 SUBROUTINE UNPP1

2.6.62.1 Purpose

Subroutine UNPP1 unpacks bytes from TIMEI and INTOI to WSLZ(7) and WSLZ(6).

2.6.62.2 Relationship

This subroutine is called from Routine P by:

```
CALL UNPP1
```

This subroutine calls UPBYT.

2.6.62.3 Assumption

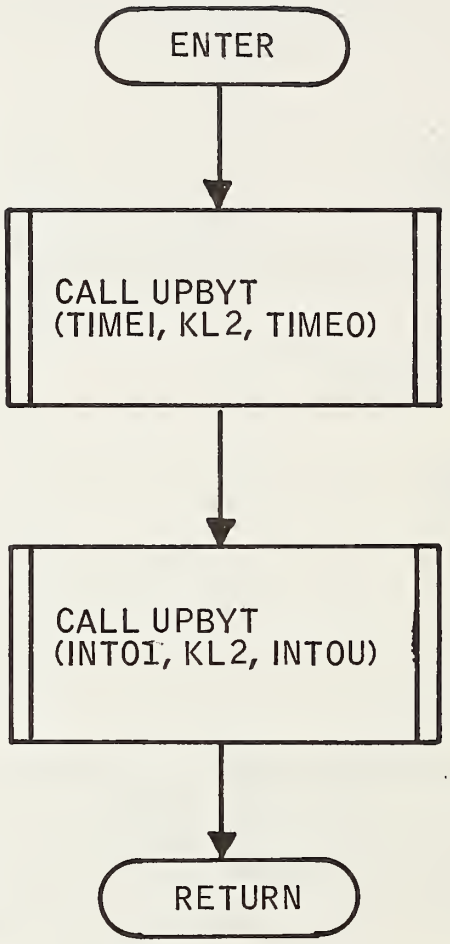
None.

2.6.62.4 Approach

Subroutine UNPP1 makes repeated calls to subtoutine UPBYT to unpack the byte specified by variable KLZ from TIMEI and INTOI, storing them in WSLZ(7) and WSLZ(6), respectively. UNPP1 then returns to the calling routine. Variable KLZ is passed through COMMON block BYTLZ.

2.6.62.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine UNPP1.

2.6.63 SUBROUTINE UNPP2

2.6.63.1 Purpose

This subroutine unpacks bytes from INTZI, INTLI, and INTHI to WSLZ(2), WSLZ(3), and WSLZ(4), respectively.

2.6.63.2 Relationship

Subroutine UNPP2 is called from Routine P by:

```
CALL UNPP2
```

This subroutine calls UPBYT.

2.6.63.3 Assumption

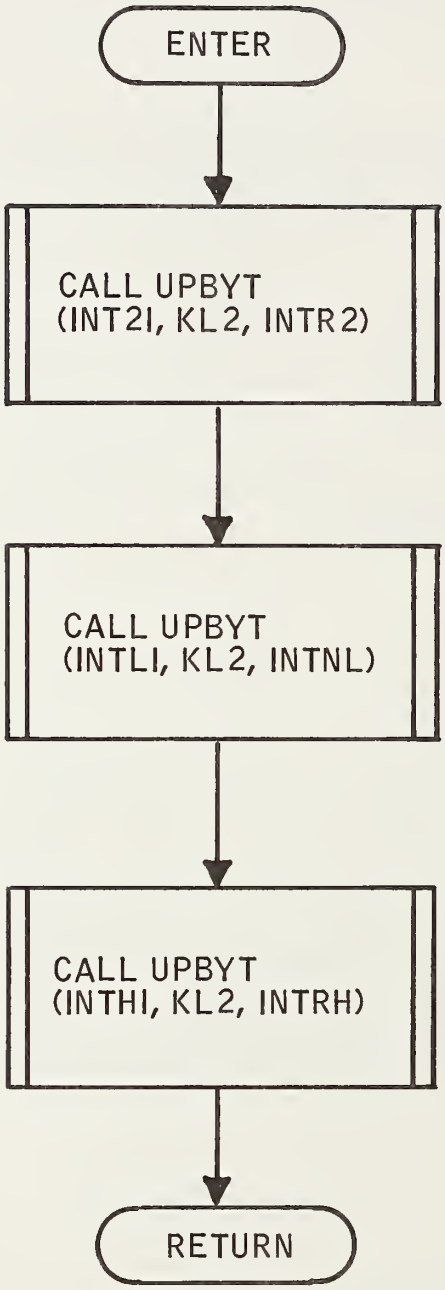
None.

2.6.63.4 Approach

Subroutine UNPP2 make repeated calls to subroutine UPBYT to unpack the byte specified by variable KL2 from INTZI, INTLI, and INTHI, sotiring them in WSLZ(2), WSLZ(3), and WSLZ(4), respectively. UNPP2 then returns to the calling routine. Variable KL2 is passed through COMMON block BYTL2.

2.6.63.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine UNPP2

2.6.64 ROUTINE Q

2.6.64.1 Purpose

Routine Q stores data on the RAD required for the next start-up, and returns control to RBM for batch processing when the entire UTCS has completed its shutdown tasks.

2.6.64.2 Relationship

Routine Q is entered on demand whenever shutdown is requested by the operator.

This routine is scheduled by Routine I. The routine calls Subroutines Q1, MOVER, and CALOP.

2.6.64.3 Assumption

None.

2.6.64.4 Approach

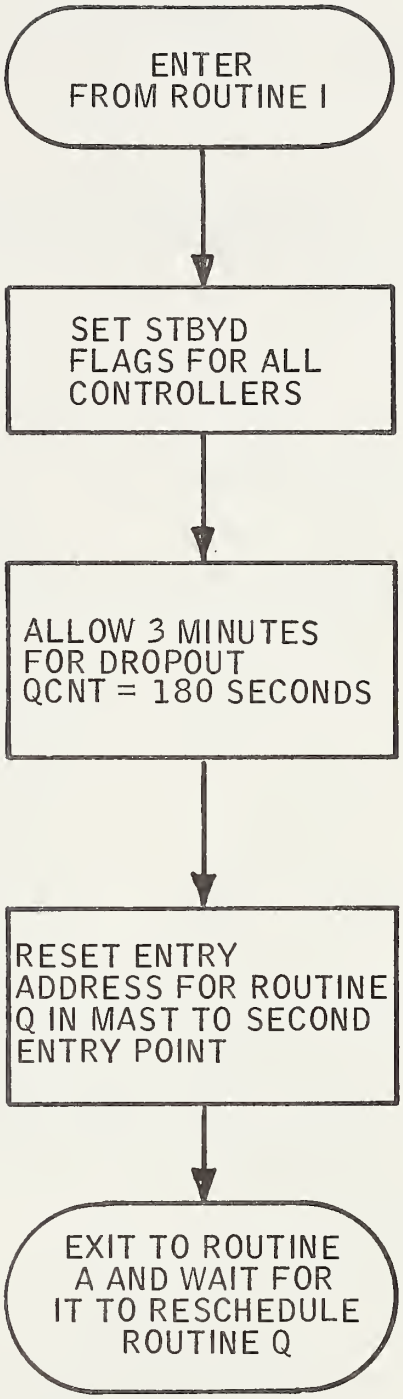
Two entries are required to complete the shutdown procedure. The first is initiated by Routine I which schedules Routine Q upon finding the shutdown flag (SHTFL) set. The first entry requests that all controllers be dropped to standby. It then sets a scheduler clock (QCNT) to 180 seconds and exits to Routine A. When Routine A decrements the clock to zero, Routine Q is re-scheduled for the second pass. The second entry stores the required arrays on the RAD and releases the UTCS program.

Routine Q has been modified to set the 5END flag upon the initial exit from this routine. This flag is initialized to zero at system start up.

When it has been set by Routine Q, it indicates to the system executive, Routine A, that on the next 5MINCT mark Priority Level 5 should be scheduled to print the predictor performance report.

2.6.64.5 Listing

See Volume III, 2GCF Routine Listings.


ENTER
FROM ROUTINE I
SET STBYD
FLAGS FOR ALL
CONTROLLERS
ALLOW 3 MINUTES
FOR DROPOUT
QCNT = 180 SECONDS
RESET ENTRY
ADDRESS FOR ROUTINE
Q IN MAST TO SECOND
ENTRY POINT
EXIT TO ROUTINE
A AND WAIT FOR
IT TO RESCHEDULE
ROUTINE Q

Routine Q

2.6.65 SUBROUTINE Q1

2.6.65.1 Purpose

This subroutine writes the shutdown file.

2.6.65.2 Relationship

Subroutine Q1 is called from Routine Q by:

```
CALL RTNQ1
```

Subroutine Q1 calls subroutines CALOP and MOVER.

2.6.65.3 Assumption

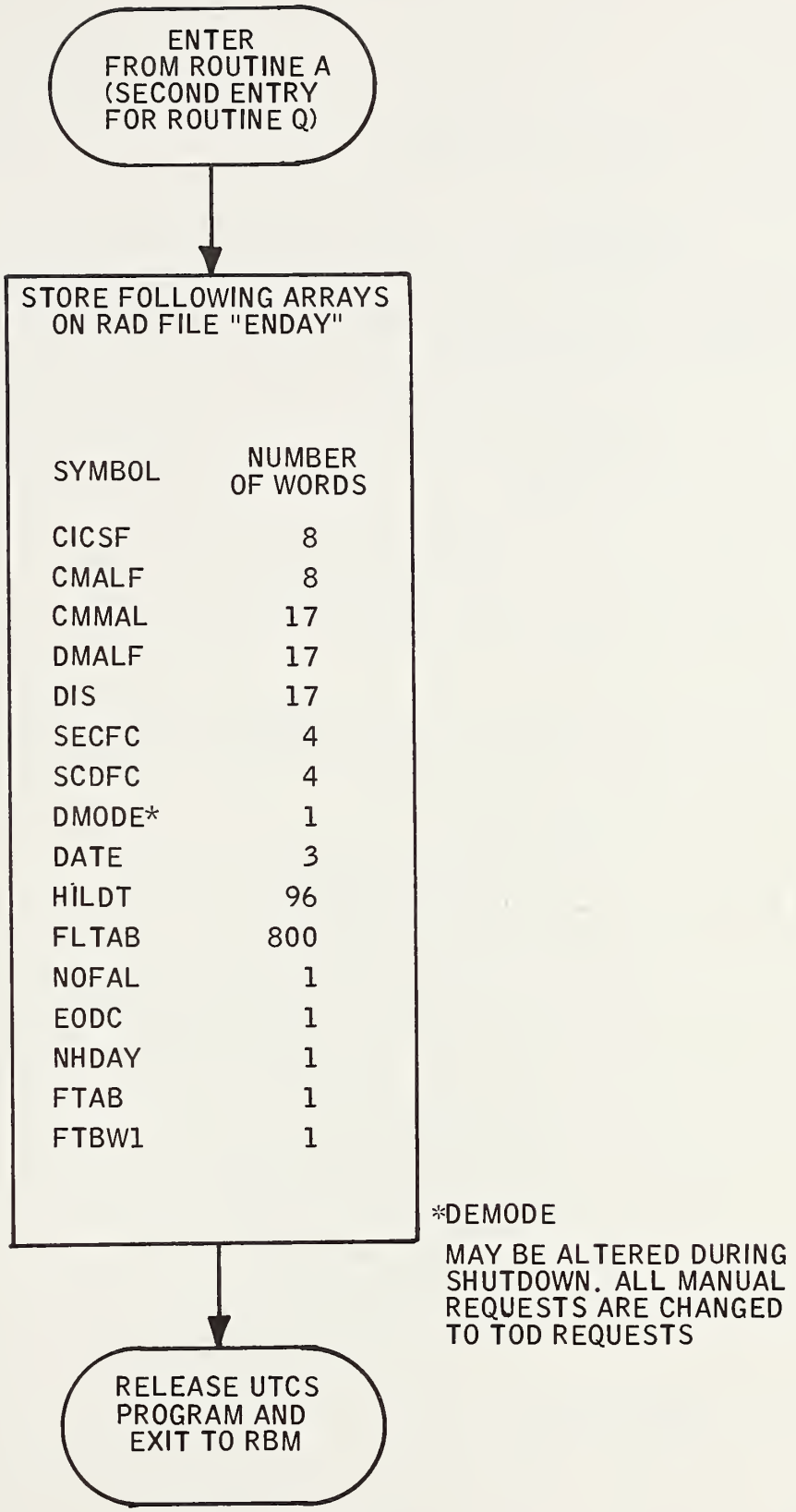
None.

2.6.65.4 Approach

Subroutine Q1 calls CALOP to open the shutdown file. Each section is examined, and if one is in manual mode, it is fed to time-of-day (TOD) operation. MOVER is then called to fill the output buffer and CALOP is called to write this buffer to the shutdown file. Q1 then returns to Q.

2.6.65.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine Q1

2.6.66 SUBROUTINE CALOP

2.6.66.1 Purpose

Subroutine CALOP opens the shutdown file (option 1) or writes the shutdown file (option 2) on the RAD.

2.6.66.2 Relationship

Subroutine CALOP is called from subroutine Q1 by:

CALL CALOP (I, J1, J2, J3, J4, J5, J6)

where:

I, J1, J2, J3, J4, J5, and J6 are the mnemonics:

I = Option flag

I = 1 to open shutdown file

I = 2 to write shutdown file

J1 = Number of fails in fail table (FLTAB)

J2 = End-of-day count (number of end of day reports)

J3 = Number of holidays

J4 = Number of bytes in fail table

J5 = Number of words in fail table

J6 = Line printer buffer pointer.

2.6.66.3 Assumption

None.

2.6.66.4 Approach

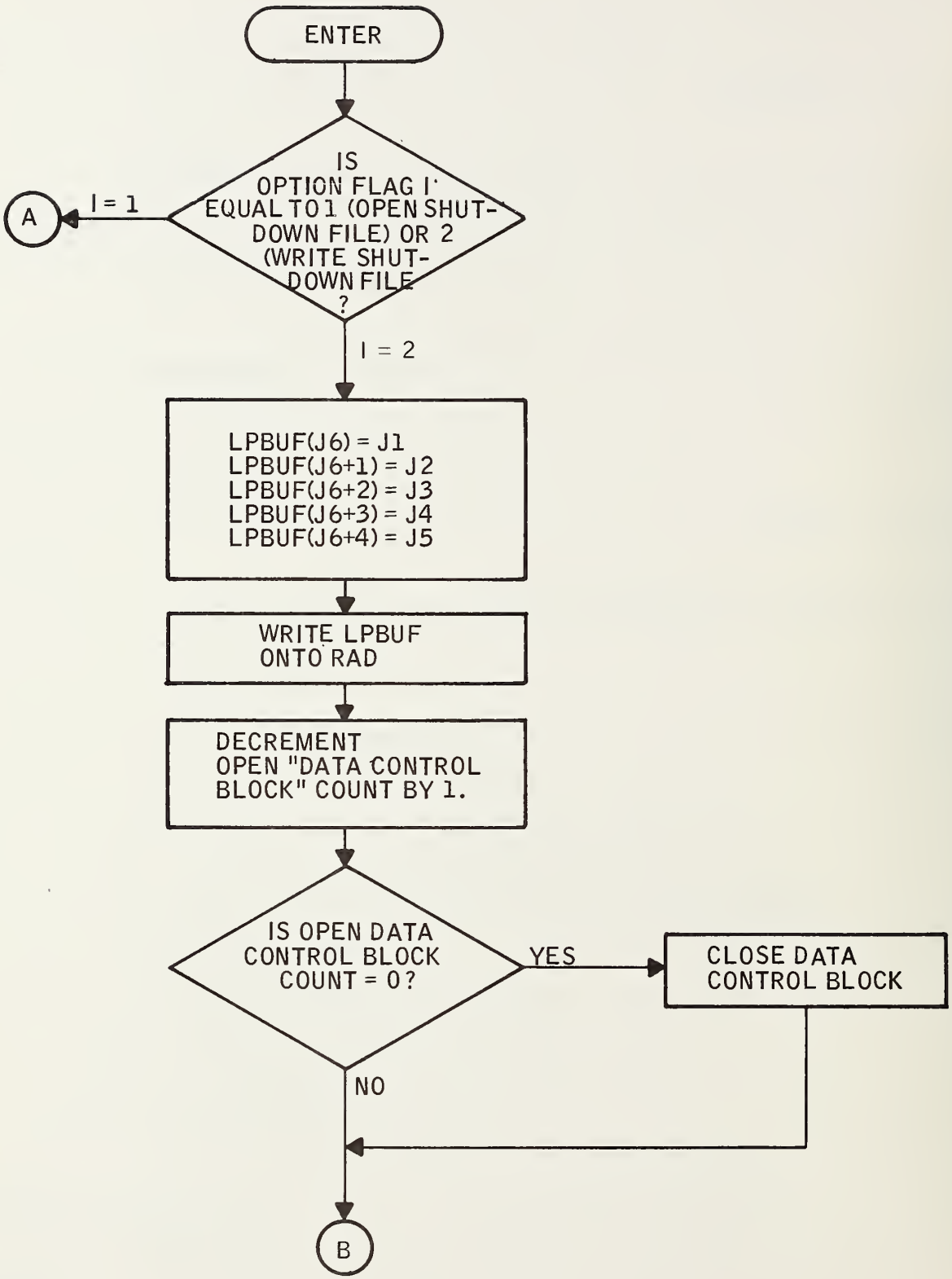
This subroutine is called from Subroutine Q1 and is therefore not required to be re-entrant.

If an error condition exists, a message is typed on the teletype.

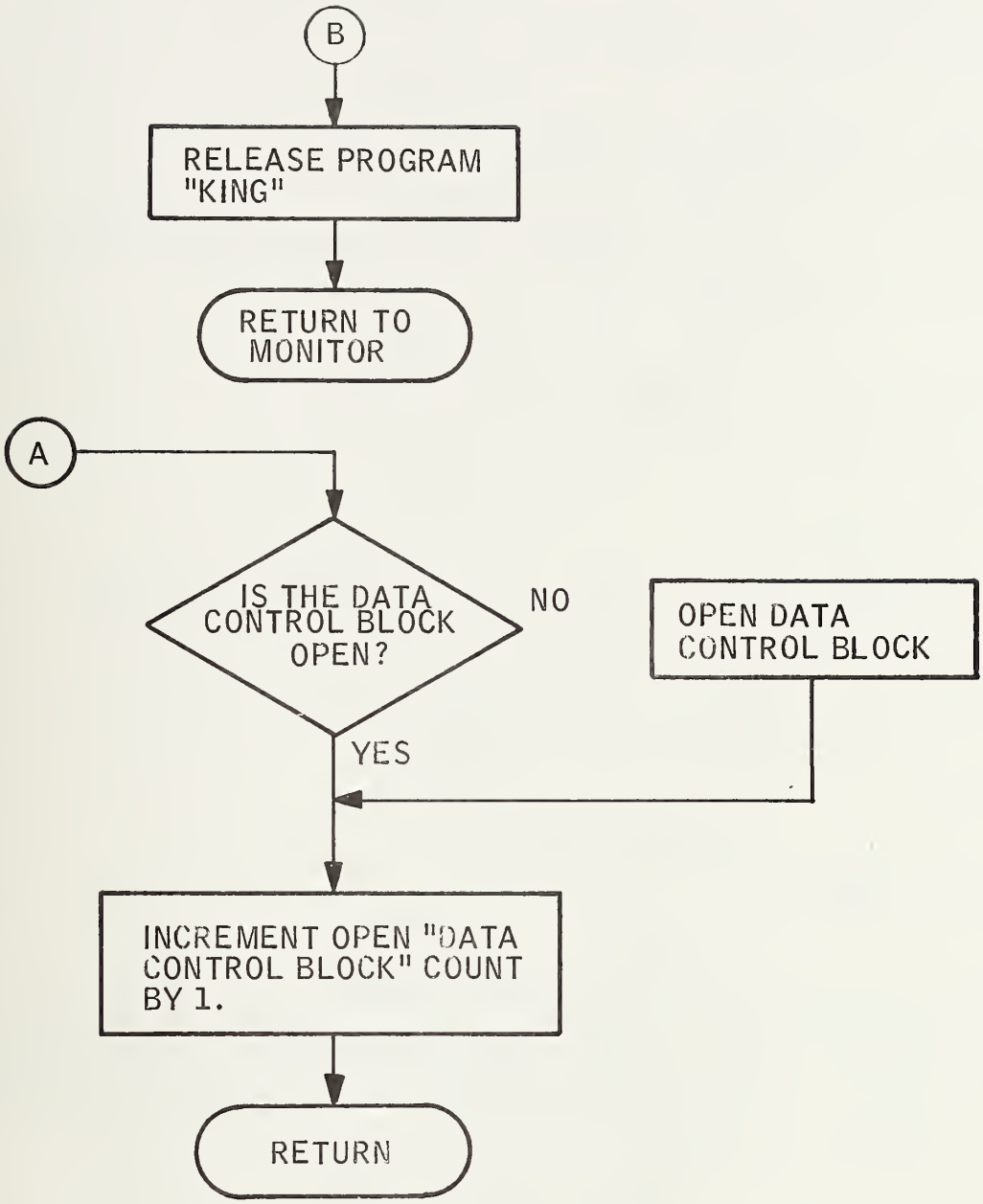
After writing the shutdown file, CALOP releases the program, ending execution.

2.6.66.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine CALOP



Subroutine CALOP (Concluded)

2.6.67 SUBROUTINE MOVER

2.6.67.1 Purpose

This subroutine transfers selected data into line printer buffer LPBUF.

2.6.67.2 Relationship

This subroutine is called by:

CALL MOVER (J)

where:

J indicates which arrays are to be transferred to the line printer buffer.

2.6.67.3 Assumption

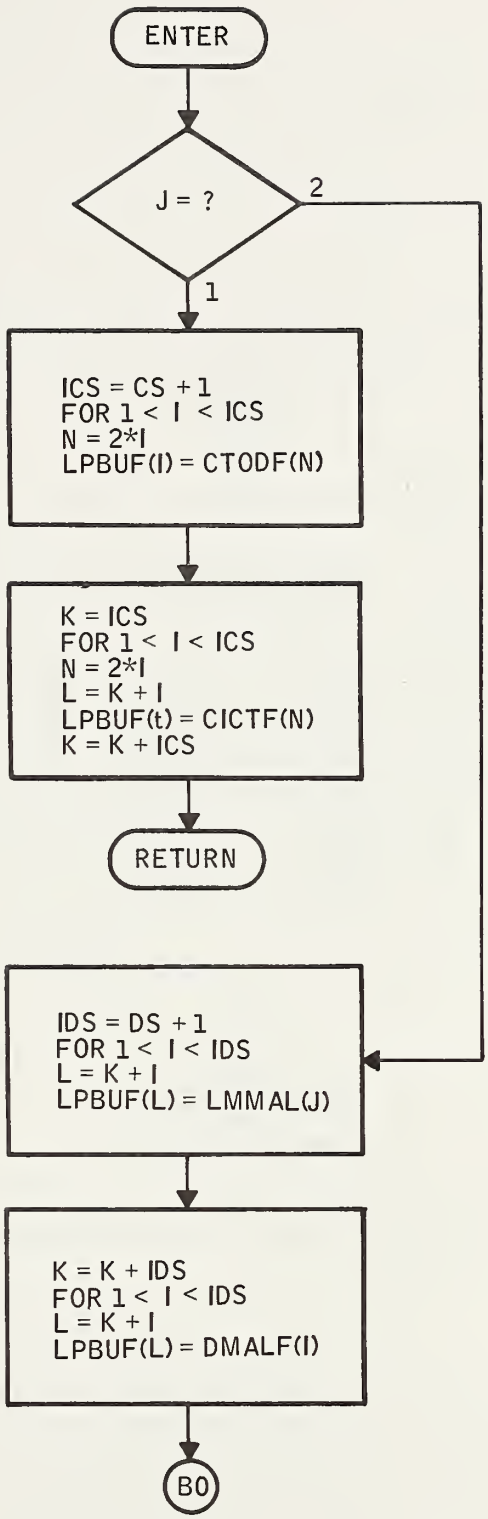
None.

2.6.67.4 Approach

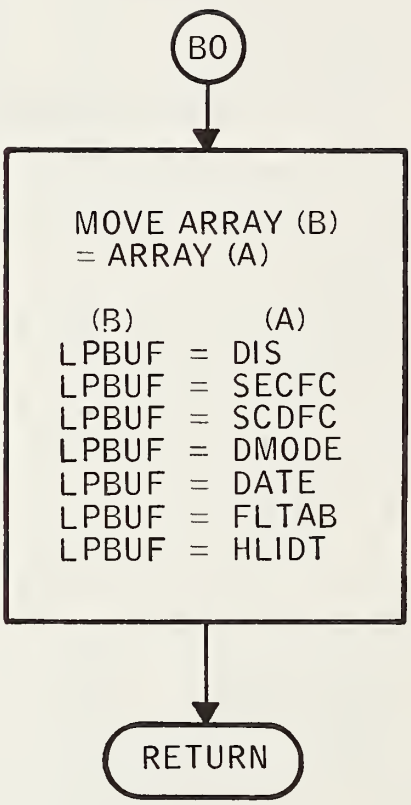
If J = 1, the contents of the CICTF and CTODF arrays are transferred to the line printer buffer (LPBUF). If J = 2, the contents of the CMMAL, DMALF, DIS, SECFC, SCDFC, DMODE, DATE, FLTAB, and HLIDT arrays are transferred to LPBUF.

2.6.67.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine MOVER



Subroutine MOVER (Concluded)

2.6.68 ROUTINE R

2.6.68.1 Purpose

Routine R effects the transition of a non-semi-actuated controller from computer control to standby, upon operator request.

2.6.68.2 Relationship

This routine is executed as part of the overall Priority Level 2 routines. It is scheduled once per second. It is entered upon completion of Routine P and exits to the Routine A1. At the start of the routine a call is made to UNPKR to unpack 32 values of STBTM. Thus STBTM is dimensioned to 32 in Routine V corresponding to 32 controllers currently being processed. At the completion of the routine a call is made to PACKR to pack the new 32 values of STBTM.

2.6.68.3 Assumption

None.

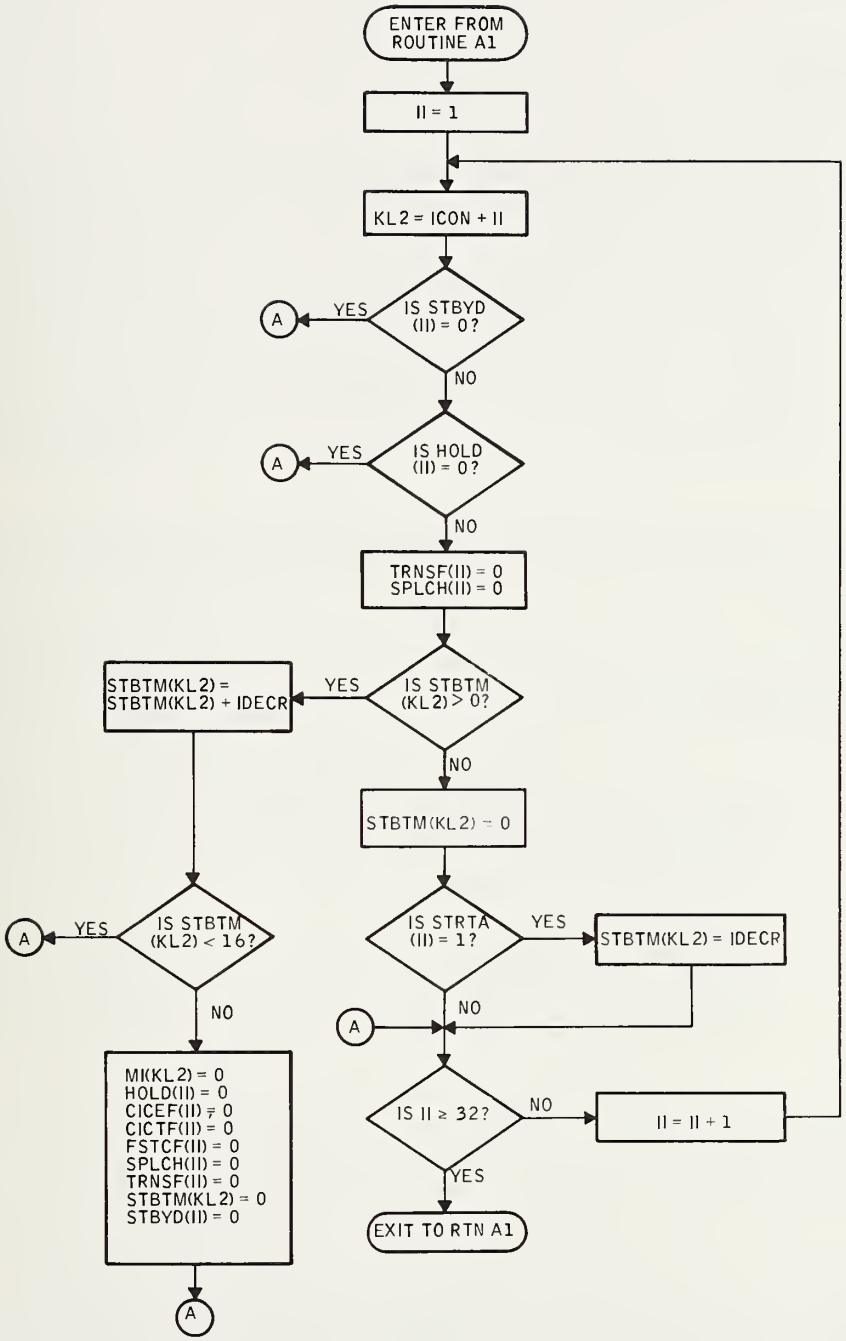
2.6.68.4 Approach

Routine R is the second routine in the Controller Do-Loop and is scheduled, unconditionally, after the termination of Routine P. As with other routines in this loop, Routine R processes 32 controllers per entry. When an operator request to drop a controller is encountered, (STBYD(I)≠O) the routine scans for the start of A-Phase Green (STRTA) for the selected

controller. When the A-Phase Green return is detected, a timeout (STBTM) of 8 seconds duration is initiated. If the request is still standing at the end of this period, the controller is dropped into standby.

2.6.68.5 Listing

See Volume III, 2GCF Routine Listings.


ENTER FROM ROUTINE A1
II = 1
KL2 = ICON + II
IS STBYD (II) = 0?
YES
A
NO
IS HOLD (II) = 0?
YES
A
NO
TRNSF(II) = 0
SPLCH(II) = 0
IS STBTM (KL2) > 0?
YES
STBTM(KL2) = STBTM(KL2) + IDECR
NO
STBTM(KL2) = 0
IS STRTA (II) = 1?
YES
STBTM(KL2) = IDECR
NO
A
IS STBTM (KL2) < 16?
YES
A
NO
MI(KL2) = 0
HOLD(II) = 0
CICEF(II) = 0
CICTF(II) = 0
FSTCF(II) = 0
SPLCH(II) = 0
TRNSF(II) = 0
STBTM(KL2) = 0
STBYD(II) = 0
A
IS II ≥ 32?
NO
II = II + 1
YES
EXIT TO RTN A1

Routine R

2.6.69 ROUTINE S

2.6.69.1 Purpose

Routine S computes the required parameters to allow a smooth transition from one area pattern to another. It preserves all safety intervals; utilizes the newly selected split for the major phases at the controller; and contains the transitional cycle length to a value between the minimum used in the section and twice that number. The transformation occurs in the minimum time, subject to the following conditions: a transition can be initiated by any of the following two conditions:

a) Controller being transferred from standby to computer control.

b) A new pattern has been selected for the section containing this controller.

Upon detection of either of these conditions the routine will compute:

a) number of intermediate cycles required

b) the intermediate cycle length

c) the intermediate variable interval durations.

2.6.69.2 Relationship

This routine is incorporated in the system as a subroutine. It is called exclusively by the Interval Advance Routine, Routine T. At entry to Routine S, a call is made to UNPS to unpack the following data for the current controller:

1. The four values for GAABC, GMABC, and SABCT.
2. CYCLC, K3PH, NMVAR, TKM.

Subroutine MBYTS is called to move entry duration values (ENINI) to a work area array (INTDI).

2.6.69.3 Assumption

None.

2.6.69.4 Approach

This routine is entered at the start of A-Phase Green if any one of the two conditions summarized above is present. The routine will perform the following computations.

1. The difference, DOFF, between the present offset and the desired new offset will be computed.
2. If negative, DOFF will be converted to its positive equivalent.
3. If the magnitude of DOFF is less than 3 seconds, no transitional cycles will be required.
4. If DOFF is greater than 3 seconds, either one or two intermediate cycles, whose cycle length is greater than a prescribed minimum value and less than twice that value, will be generated.
5. If there are more than two adjustable interval durations at the controller (or more than three for a Type B multiple-phase critical intersection controller), all of those intervals above this number will be set to a defined minimum value.

6. The split during the transitional cycles will be apportioned according to the following logic:

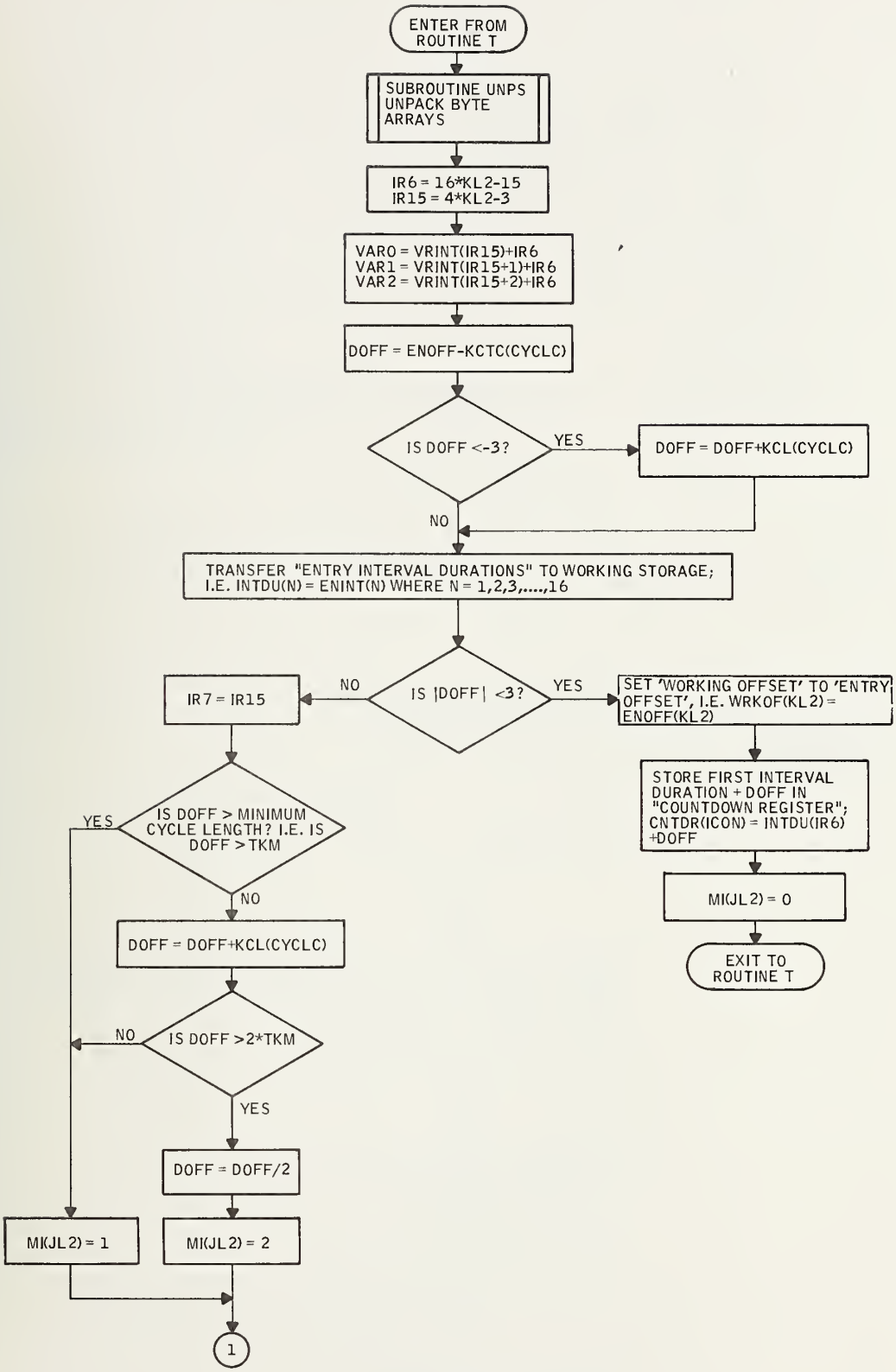
   a) The durations of all safety intervals will be maintained.

   b) The adjustable interval durations associated with all the minor movements will be set equal to their respective minimum values. The residual cycle time will be apportioned to the two or three major movements according to the procedure below.

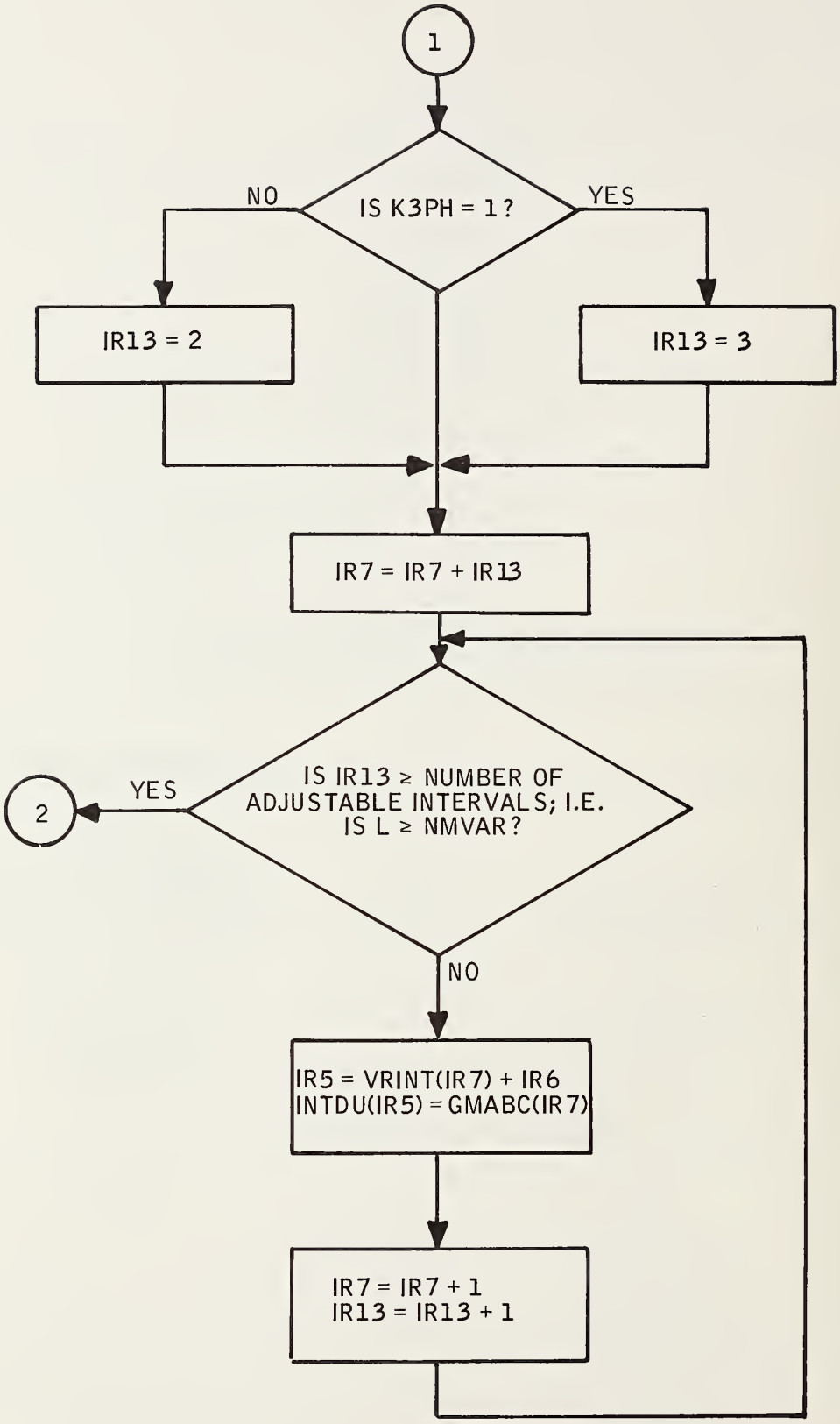
   c) The split for these two or three major movements will be set equal to that value which will be used after the transitional cycles have been completed.

2.6.69.5 Listing

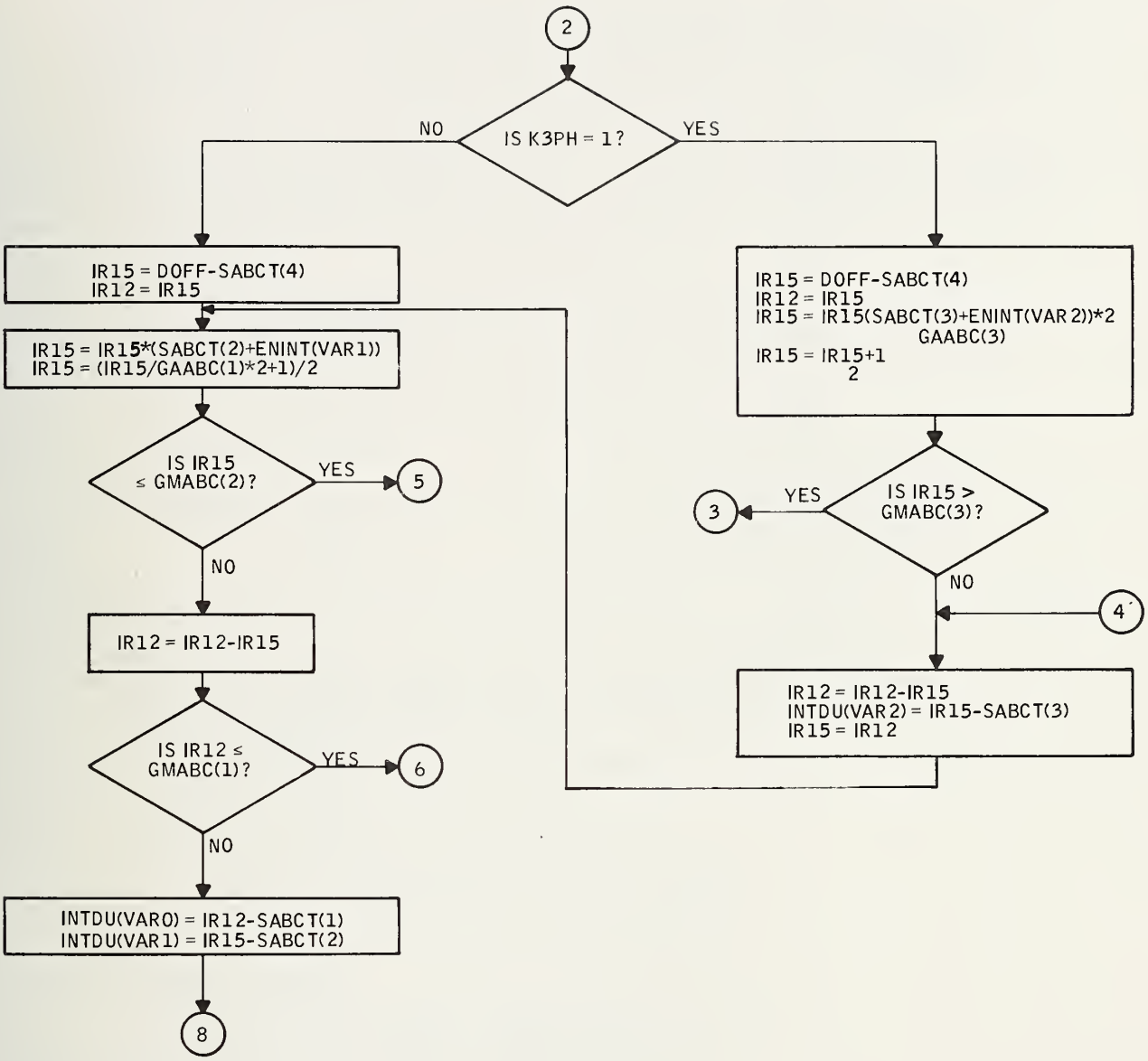
See Volume III, 2GCF Routine Listings.


ENTER FROM ROUTINE T
SUBROUTINE UNPS UNPACK BYTE ARRAYS
IR6 = 16*KL2-15
IR15 = 4*KL2-3
VAR0 = VRINT(IR15)+IR6
VAR1 = VRINT(IR15+1)+IR6
VAR2 = VRINT(IR15+2)+IR6
DOFF = ENOFF-KCTC(CYCLC)
IS DOFF <-3?
YES
DOFF = DOFF+KCL(CYCLC)
NO
TRANSFER "ENTRY INTERVAL DURATIONS" TO WORKING STORAGE; I.E. INTDU(N) = ENINT(N) WHERE N = 1,2,3,....,16
IS |DOFF| <3?
NO
YES
IR7 = IR15
SET 'WORKING OFFSET' TO 'ENTRY OFFSET', I.E. WRKOF(KL2) = ENOFF(KL2)
STORE FIRST INTERVAL DURATION + DOFF IN "COUNTDOWN REGISTER"; CNTDR(ICON) = INTDU(IR6) +DOFF
MI(JL2) = 0
EXIT TO ROUTINE T
IS DOFF > MINIMUM CYCLE LENGTH? I.E. IS DOFF > TKM
YES
NO
DOFF = DOFF+KCL(CYCLC)
IS DOFF >2*TKM
NO
YES
DOFF = DOFF/2
MI(JL2) = 1
MI(JL2) = 2
1

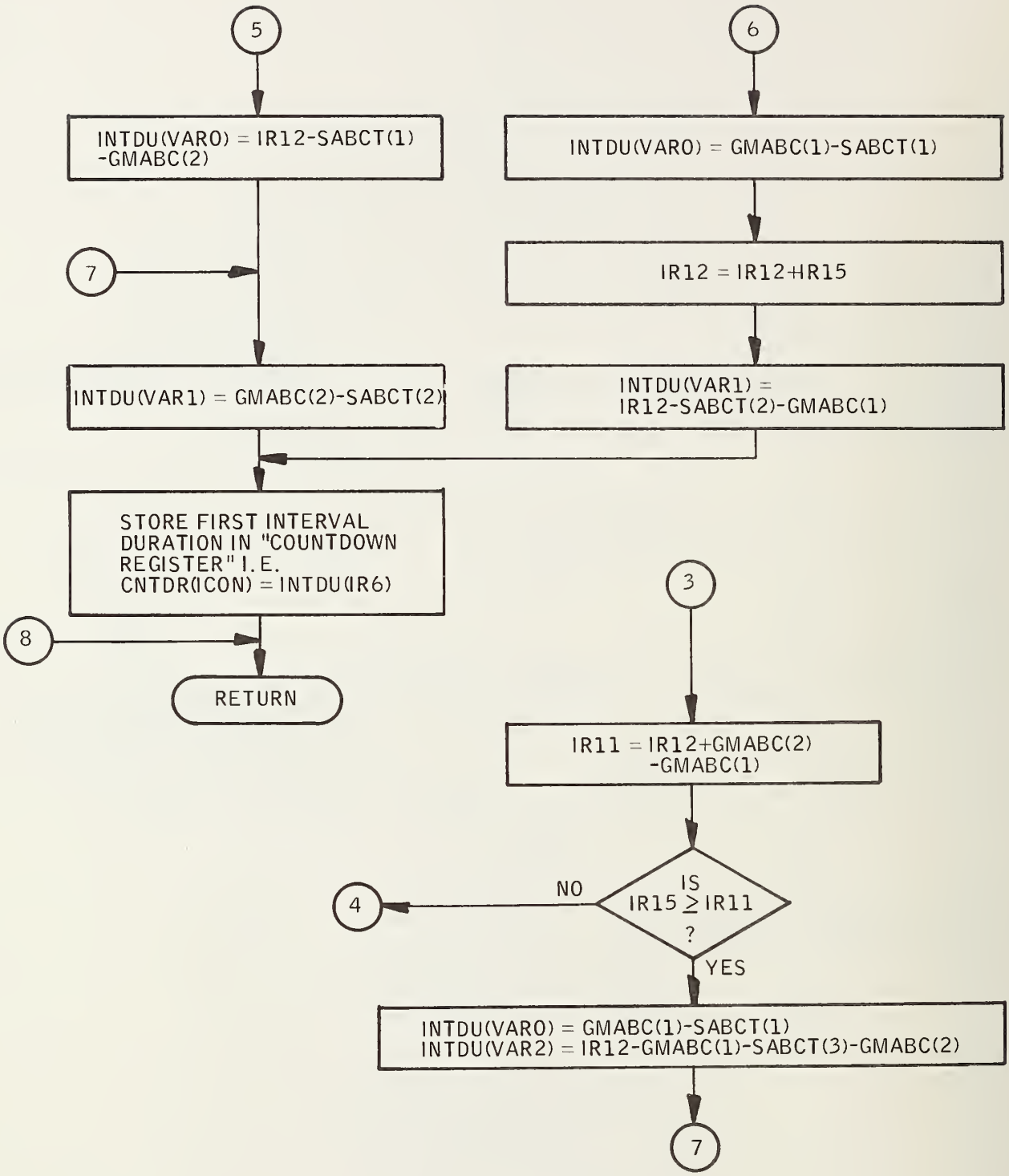
Routine S



Routine S (Continued)



Routine S (Continued)



Routine S (Concluded)

2.6.70 SUBROUTINE MBYTS

2.6.70.1 Purpose

The purpose of Subroutine MBYTS is to efficiently move strings of byte data from entry storage into working storage. The entry and working storage arrays are discussed in Section 1.5 of Reference 4.

2.6.70.2 Relationship

This subroutine is called by:

CALL MBYTS (X, Y, I, N)

where:

X, Y, I, and N are the mnemonics:

X = Entry byte string. (Source of bytes to be moved.)
Y = Working byte string. (Destination of bytes to be moved.)
I = Starting byte index for X. (Index of first byte of array X to be moved.)
N = Number of bytes to be moved.

2.6.70.3 Assumption

None.

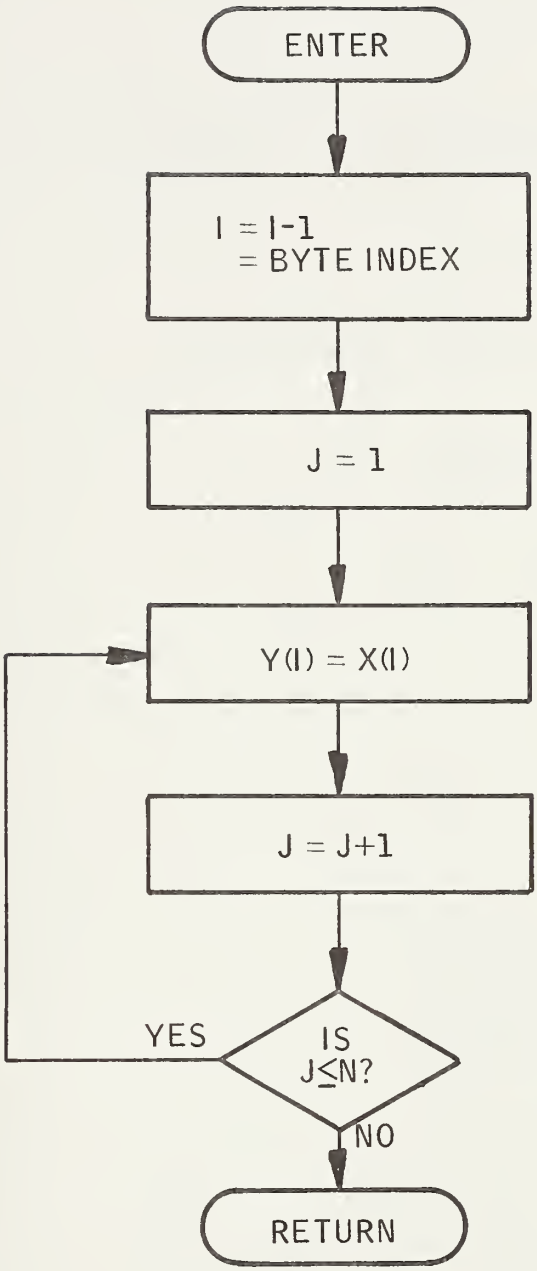
2.6.70.4 Approach

This subroutine is called exclusively by the Priority Level 2 Routines T and S and therefore has no re-entrancy requirement.

It should be noted that the index I is a FORTRAN index and as such, must be decremented by one in the subroutine to obtain the proper assembly language index to access the array.

2.6.70.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine MBYTS

2.6.71 SUBROUTINE UNPS

2.6.71.1 Purpose

Subroutine UNPS unpacks bytes from variables in BLOCK18 into WSLZ.

2.6.71.2 Relationship

This subroutine is called from Routine S by:

```
CALL UNPS
```

This subroutine calls UPBYT.

2.6.71.3 Assumption

None.

2.6.71.4 Approach

Unpack all bytes

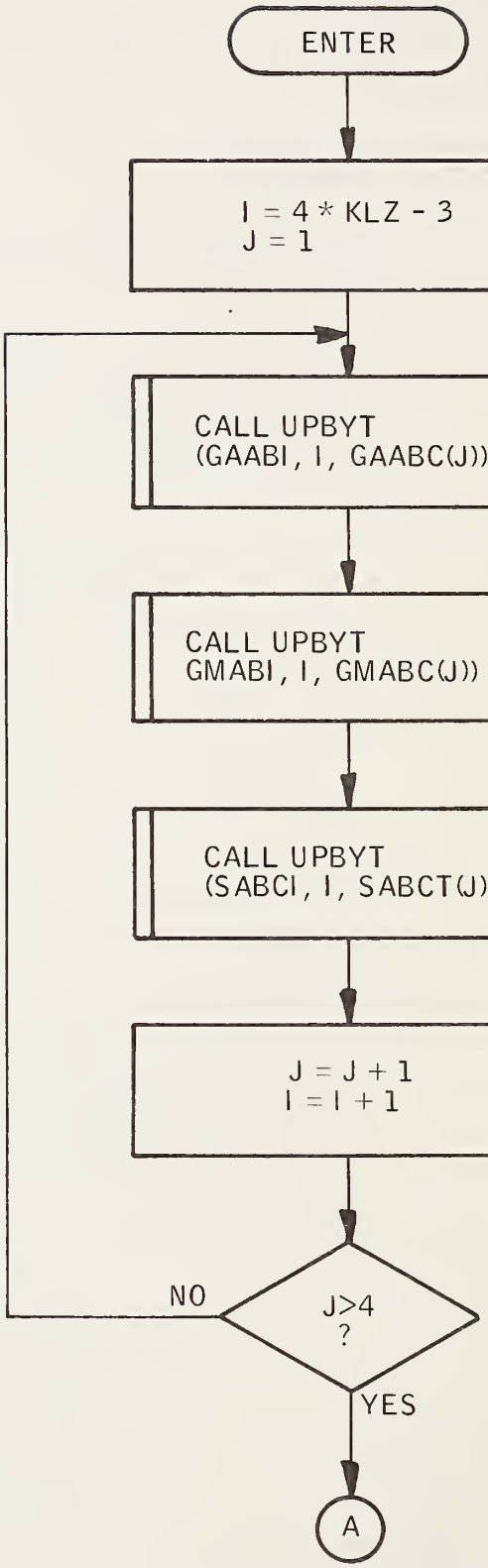
From	To
GAABI	WSLZ (10-13)
GMABI	WSLZ (14-17)
SABCI	WSLZ (20-23)

Unpack the fourth byte

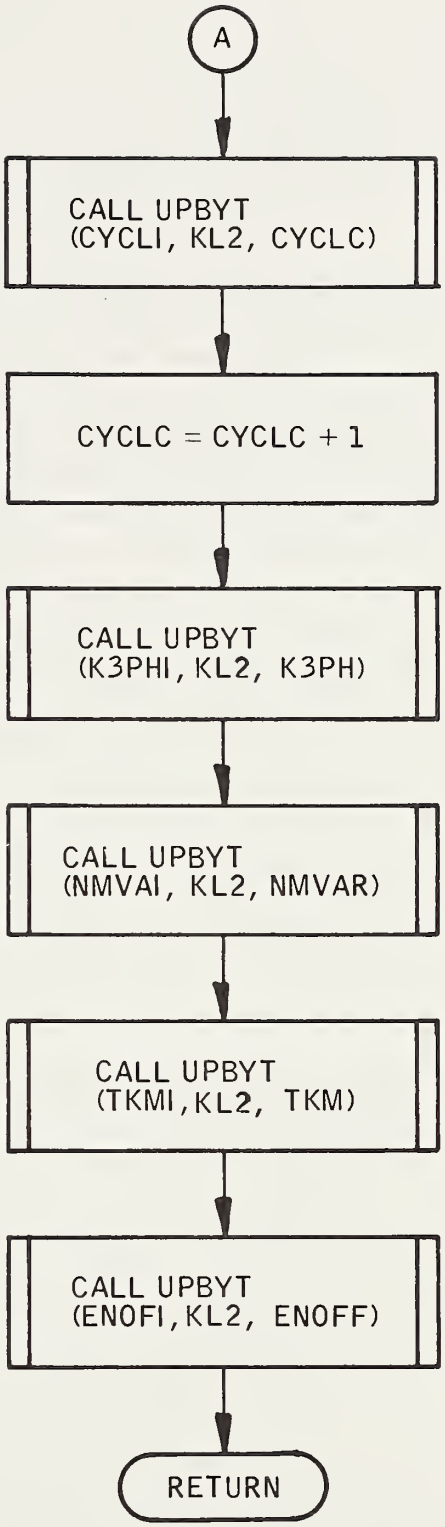
From	To
CYCLI	WSLZ (9)
K3PHI	WSLZ (18)
NMVAI	WSLZ (19)
TKMI	WSLZ (24)
ENOFI	WSLZ (43)

2.6.71.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine UNPS



Subroutine UNPS (Concluded)

2.6.72 ROUTINE T

2.6.72.1 Purpose

The primary functions of Routine T are to:

- Establish and impose the necessary transition cycles to transform a controller from standby to computer control. This transition is initiated at the start of A-Phase Green provided the necessary input conditions are satisfied.

- Count down, by subtracting 1 second per pass through the routine, the interval durations for those controllers under computer control. When the count goes to zero the interval number is incremented by 1 and tested for the maximum. If the maximum is exceeded, the interval number is reset to 1 and the countdown register is initialized to the first interval duration. Otherwise, the next interval duration is stored into the countdown register.

- Provide the capability to incorporate operator selected values of split or offset at the start of interval one.

2.6.72.2 Relationship

Routine T is part of the Level 2 Do-Loop and is executed every second. Routine T may call the following routines:

- Routine S – Transition Routine
- Routine U – Offset Correction Routine

It is entered after Routine R and exits to Routine A1. If conditions are satisfied for any controller a call is made to UNPT to unpack INTR2, and INTRH, and for that controller. After processing that controller a call is made to PCKT to pack INTNM and INTNL for that controller.

2.6.72.3 Assumption

None.

2.6.72.4 Approach

This routine checks for the presence of the "Automatic Control Desired Flag" for those controllers which are in standby. If these conditions are met, the controller will be placed under computer control at the beginning of the next A-Phase Green. At this time, the "Automatic Control Desired Flag" will be cleared, and the interval number count will be initiated at 1. The next step is call of Routine S, Transition Routine, which will compute the required intermediate cycle, split, and offset to effect the change to the computer-selected cycle, split, and offset.

Under normal computer control, this routine will decrement an interval "Count-Down Register" every 1 second until zero is reached. At this time the following sequence of events will be initiated:

1. If the "Advance Pulse Inhibit Flag" (ADVNH) has not been set by Routine P, Synchronization of Controller with Computer, the "Interval Advance Pulse" (IADVP) will be set.

2. If the "Advance Pulse Inhibit Flag" is set, it will be cleared at this time, and no "Interval Advance Pulse" will be transmitted.

3. The "Interval Count" will be updated by one and will be checked for exceeding the highest numbered interval.

4. If the highest numbered interval has not been exceeded, the next interval duration will be stored in the "Count-down Register" (CNTDR). If the highest numbered interval has been exceeded, the "Interval Count," (INJNM) will be reset to one, and some combination of the following functions will be performed.

    - Transitional cycle(s) will be initiated to transfer to a new selection of cycle, split, and offset if the "Transition Flag" (TRNSF) is set. These flags are set whenever a new timing pattern is being imposed.

    - A transition already in effect will be continued for one additional cycle if the MI count is non-zero. There will be a maximum of two intermediate cycles. The MI count is determined by computations in Routine S and is indicative of the minimum number of cycles necessary to impose the selected timing pattern on a given controller.

- An operator split change will be introduced if the "Operator Split Change Flag" (SPLCH) is set, and a transition is not in effect as evidenced by the "Transition Flag" or the MI count.

- An operator offset change will be introduced at this time, by calling Routine U, if new offset data has been selected, and a transition is not in effect. If should be noted that a transition will override either an operator split selection or an operator offset selection.

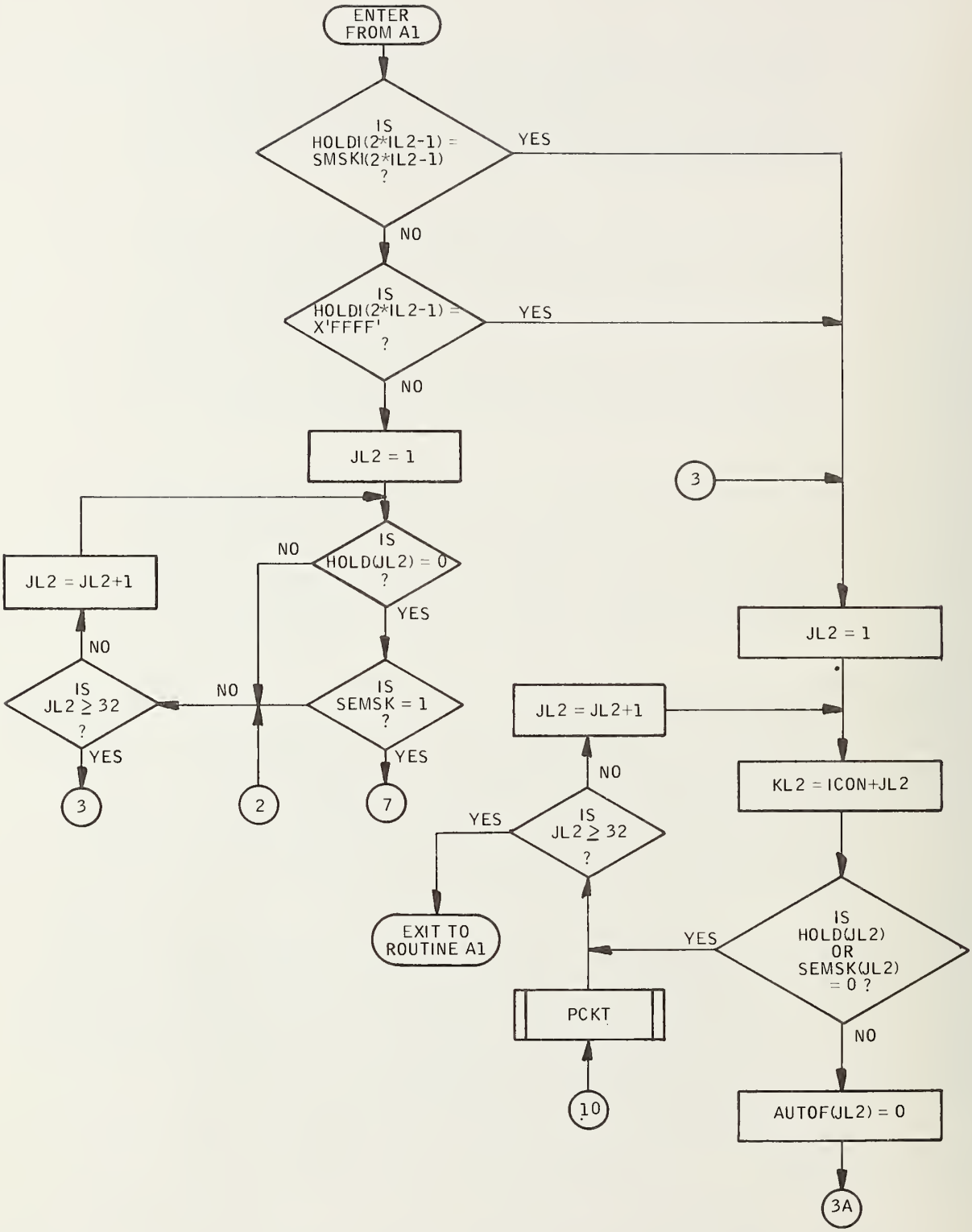
- Any cumulative offset error which has accrued over the preceding cycle will be adjusted at this time by calling Routine U, Offset Correction Routine, provided the program is not in a transitional cycle.

Immediately following the transfer of "Entry Offsets" into working storage, a test is performed on the "Split Flag." If the flag is set, indicating intersection splits were transferred to working storage in Routine W, the B- and C-Phase offsets are calculated from the A-Phase offset and splits, and the A-, B-, and C-Phase offsets are stored in the array WRKOFS.

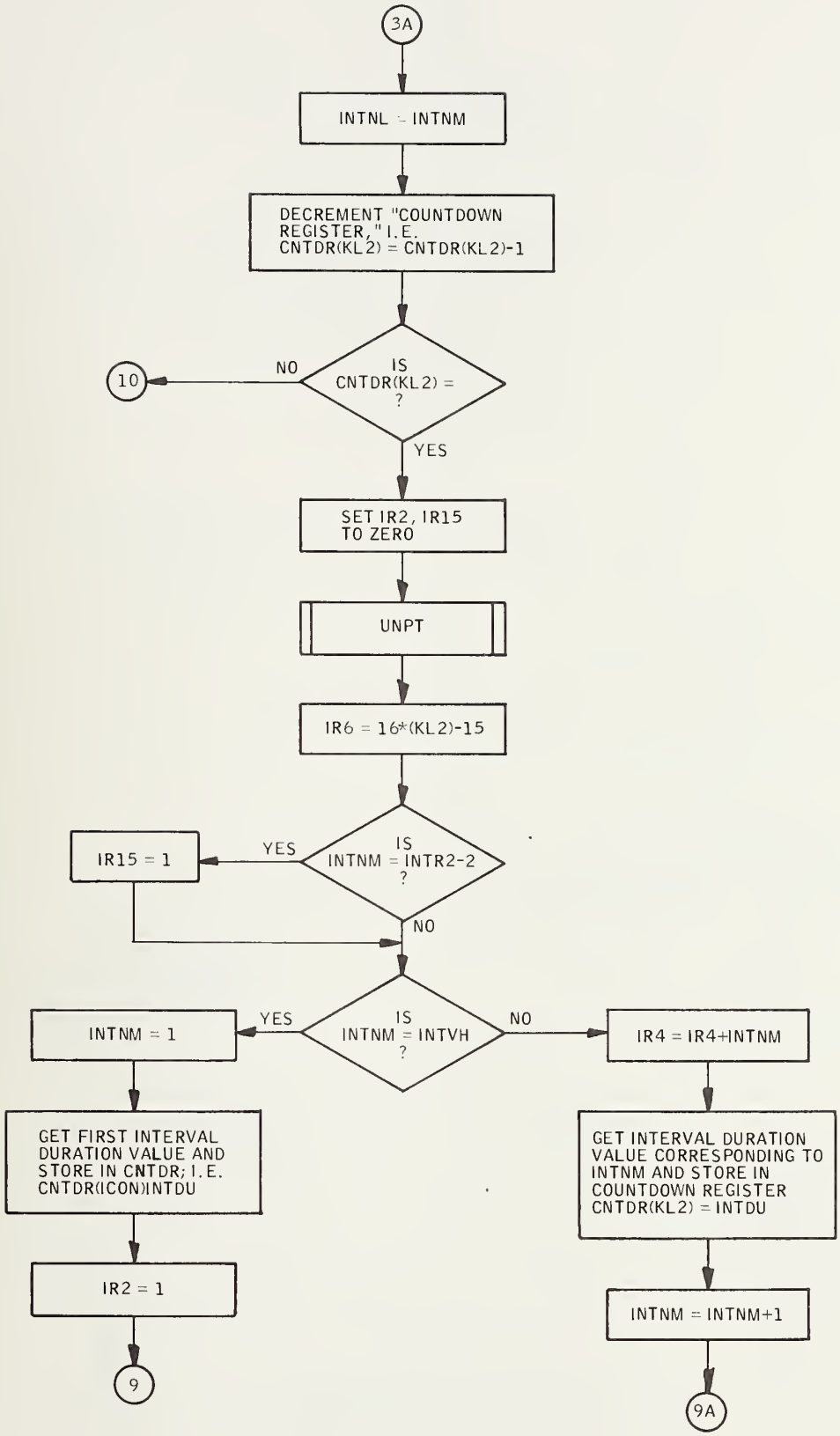
Immediately prior to a call to Routine S, Transition Routine, coding has been added to transfer the Entry Cycle Length code (ENTCYCL) into the working Cycle Length Code (CYCLC). This transfer is necessary because ENTCYCL is not equated to CYCLC in the second generation software for reasons described in the Routine W discussion.

2.6.72.5 Listing

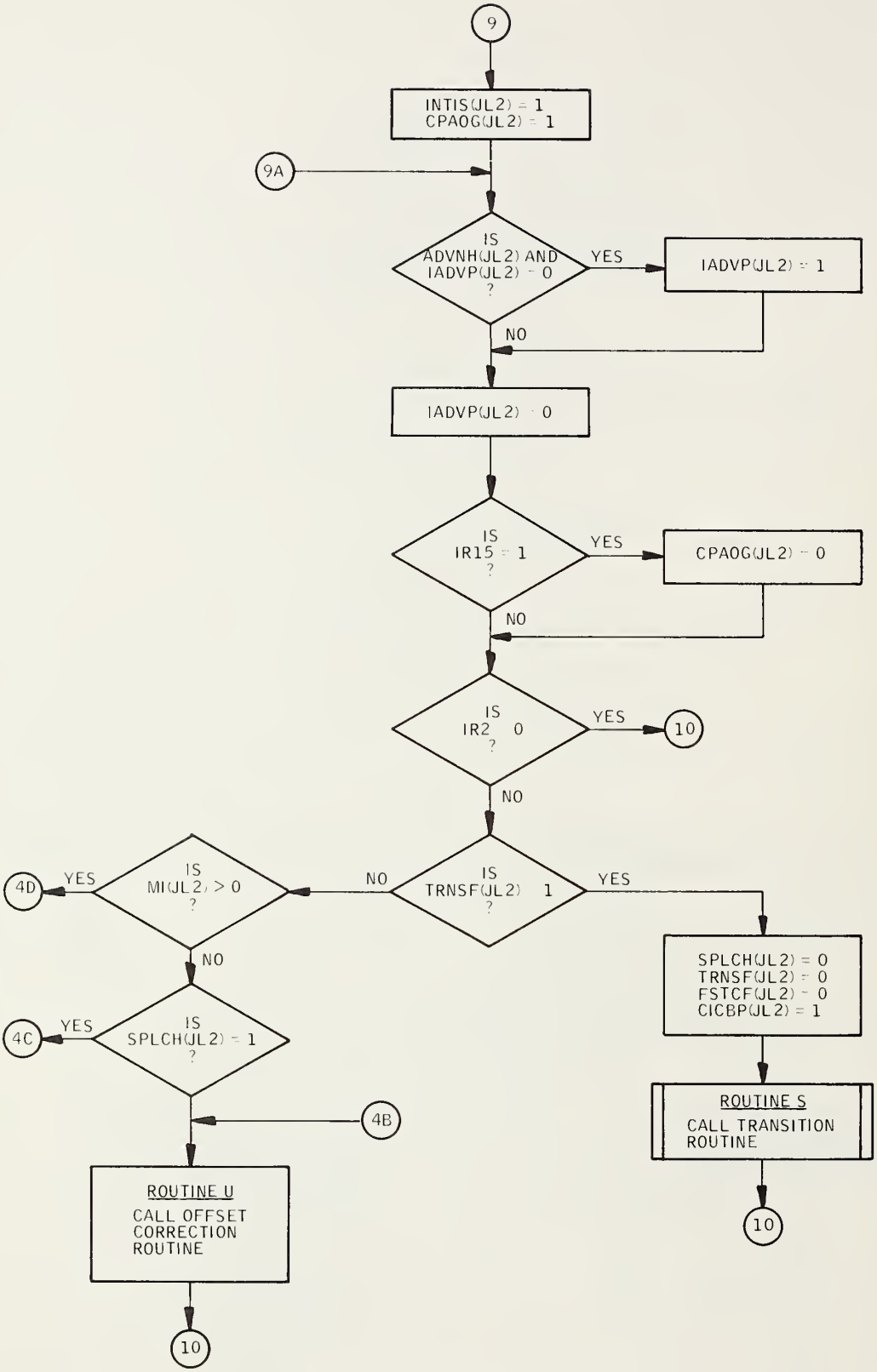
See Volume III, 2GCF Routine Listings.


ENTER FROM A1
IS HOLDI(2*IL2-1) = SMSKI(2*IL2-1) ?
YES
NO
IS HOLDI(2*IL2-1) = X'FFFF' ?
YES
NO
JL2 = 1
3
IS HOLD(JL2) = 0 ?
NO
YES
JL2 = JL2+1
NO
IS JL2 ≥ 32 ?
NO
YES
IS SEMSK = 1 ?
YES
3
2
7
JL2 = 1
JL2 = JL2+1
KL2 = ICON+JL2
NO
IS JL2 ≥ 32 ?
YES
EXIT TO ROUTINE A1
IS HOLD(JL2) OR SEMSK(JL2) = 0 ?
YES
PCKT
10
NO
AUTOF(JL2) = 0
3A

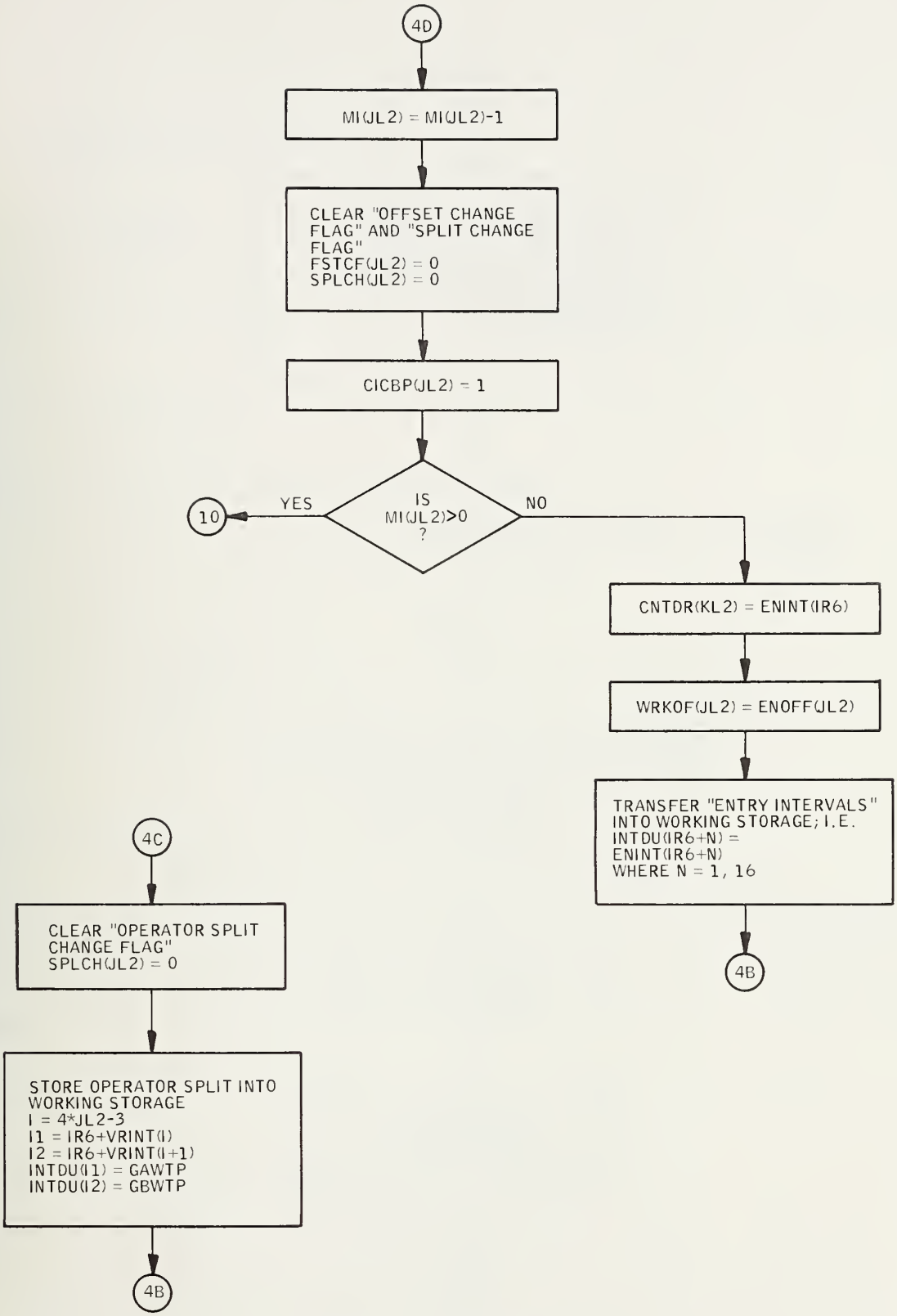
Routine T



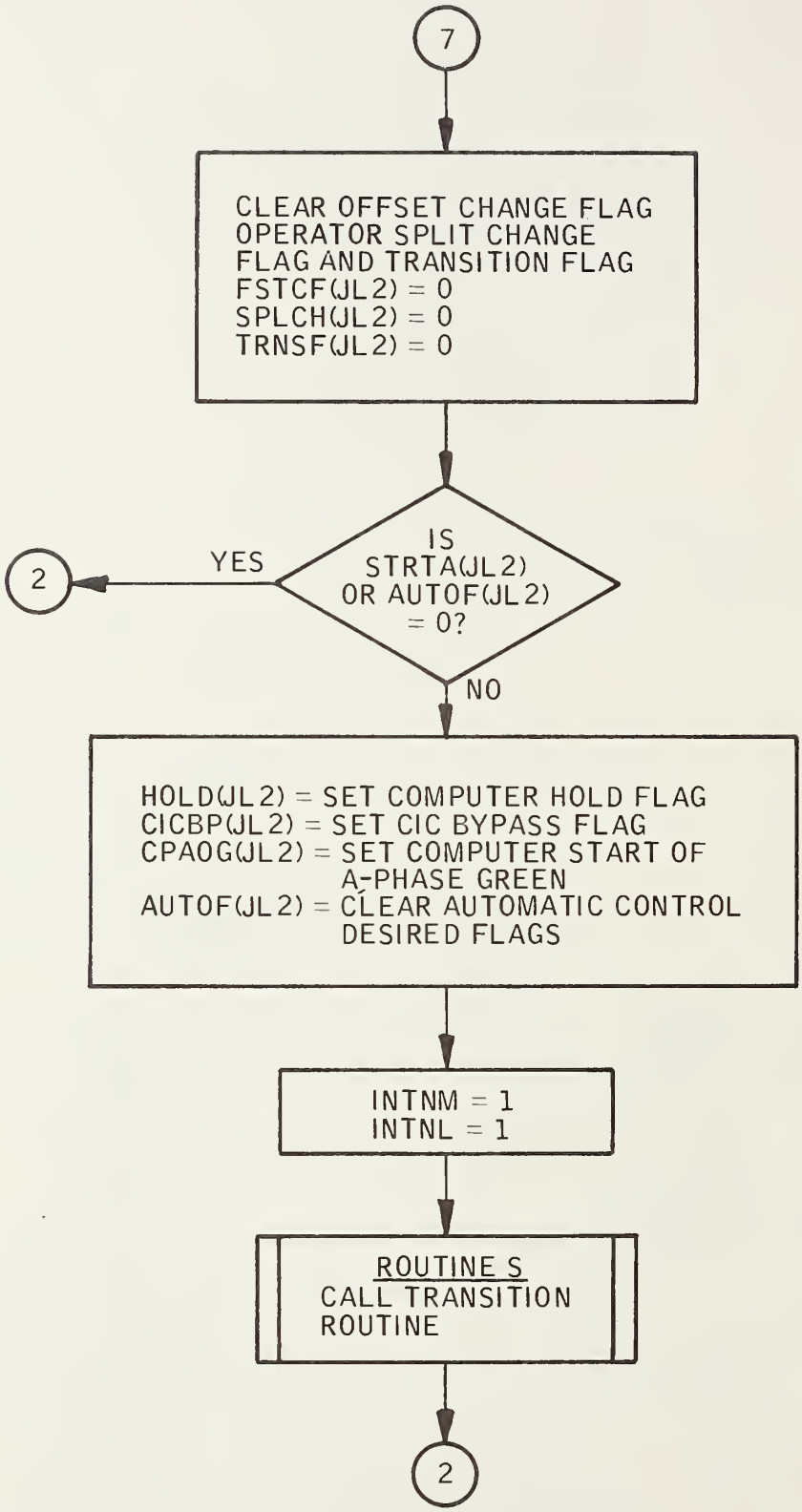
Routine T (Continued)



Routine T (Continued)



Routine T (Continued)



Routine T (Concluded)

2.6.73 SUBROUTINE PCKT

2.6.73.1 Purpose

This subroutine packs bytes from WSLZ (6) into INTMI, and WSLZ (7) into INTLI.

2.6.73.2 Relationship

This subroutine is called from Routine T by:

```
CALL PCKT
```

This subroutine calls PKBYT.

2.6.73.3 Assumption

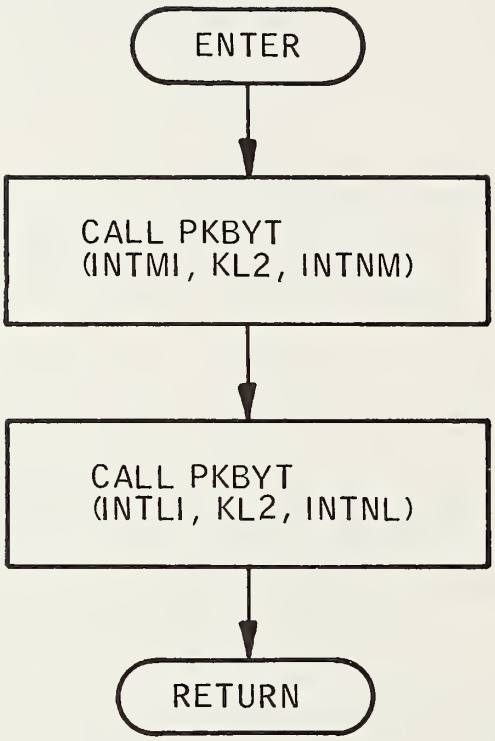
None.

2.6.73.4 Approach

Subroutine PCKT calls on subroutine PKBYT to store WSLZ(6) and WSLZ(7) into the KL2 byte of INTMI and INTLI, respectively. Variable KL2 is passed through COMMON block BYTL2. PCKT then returns to the calling routine.

2.6.73.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine PCKT

2.6.74 SUBROUTINE UNPT

2.6.74.1 Purpose

Subroutine UNPT unpacks bytes from INTZI and INTHI to WSLZ(4) and WSLZ(5).

2.6.74.2 Relationship

This subroutine is called from Routine T by:

```
CALL UNPT
```

This subroutine calls UPBYT.

2.6.74.3 Assumption

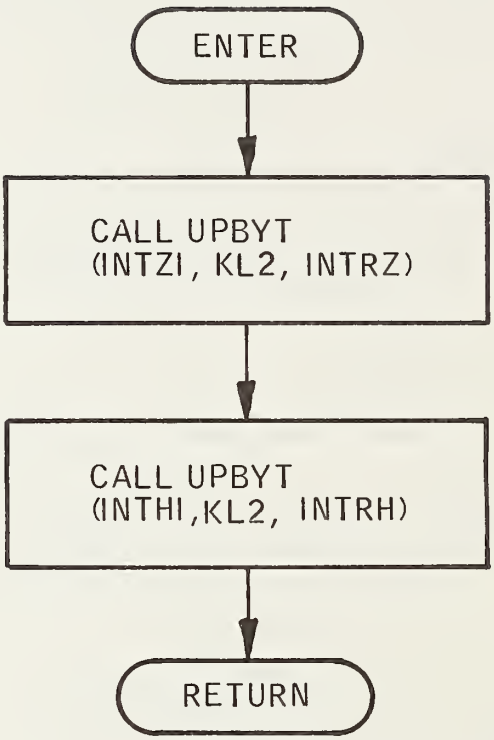
None.

2.6.74.4 Approach

Subroutine UNPT calls UPBYT to unpack the byte in INTZI and the byte in INTHI indexed by KL2. Variable KL2 is passed in COMMON block BYTL2. UNPT stores these bytes in WSLZ(4) and WSLZ(5), then returns to the calling routine.

2.6.74.5 Listing

See Volume III, 2GCF Routine Listings.



Subroutine UNPT

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